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OIL INDUSTRY OUTLOOK

EIGHTH EDITION • 1992-1996

ROBERT J. BECK

ECONOMICS EDITOR

OIL & GAS JOURNAL

PennWell Books

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OIL INDUSTRY OUTLOOK

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FOREWORD

The Iraqi occupation of Kuwait in August 2, 1990, brought shock waves throughout the oil markets of the world. Although the price of a barrel of oil reached $40 by October of the same year, the Kingdom of Saudi Arabia substantially increased its oil production to fill the shortfall. This oil policy brought back a good degree of stability to oil markets.

Despite the ominous situation caused by the invasion of Kuwait, the price of oil came down to nearly $25 per barrel and fluctuated between $20–25 for a long time. This was the market's reaction to an increase in Saudi oil production from about 4.5 to nearly 6.5 million barrels per day. Also, Venezuela added its share to fill the gap in oil production. Lost oil exports from Iraq and Kuwait amounted to 4.5 million barrels per day. Stockpiles of oil in Europe and Japan, along with the U.S. Strategic Petroleum Reserves, contributed to lowering the price per barrel of oil despite the imminent threat of war.

Immediately after the United Nation's deadline for Iraq to withdraw from Kuwait, the war for liberating Kuwait had begun. Oil market reaction was one of confidence without the normal upward reaction to war psychology. In fact, the price of oil went down and the stock market went up.

On the 25th of January, 1991, an act of environmental terrorism took place in the Arabian Gulf on the eastern shores of Kuwait. Crude oil from the pumping stations at Mina Al-Ahmadi was purposely dumped into the Gulf waters. Huge amounts of oil, exceeding two million barrels per day, were released as an act of war, severely polluting the ecosystem of the Gulf. This war strategy proved to be of no practical value from a military point of view, but it caused terrible ecological damage to the environment as a whole and was especially destructive to marine life. By early March 1991, this spill was estimated to be approximately four million barrels of oil per day.

As a result of this futile act against mankind and environment, nearly 11 million barrels of oil were deliberately released. This is equivalent to 462 million gallons, about 1.7 million tons of spilled oil, compared to only 11 million gallons of crude oil spilled during the 1989 Exxon Valdez Oil Spill. This makes it the largest oil spill in history!

After the Gulf was ravaged with several oil spills during the war, other environmental tragedies struck. Their reverberating impact will linger on for many years. On February 23–27, 1991, another unique act of environmental terrorism was commited against the state of Kuwait by burning 600 of its oil wells. These well fires were burning about 5 million barrels of oil per day. From the time an armada of oil well fire fighters began their arduous task in March 1991, it took only until November 1991 to stop all of these oil well fires.

Kuwait was free again on February 28, 1991. However, Kuwait was in ruins, and its oil and gas industry was in shambles.

Despite all this calamity, oil markets remained rather stable. Also natural gas markets were stabilized; prices per million BTU of natural gas remained lower than those for oil. Cost for liquefied natural gas was reaching upward to have parity with oil.

The largest oil producer in the world, the USSR, earned approximately half of its hard currency from oil and gas exports. However, its oil production had been steadily declining from 12.4 million barrels per day in 1988 to 10.3 million barrels per day in 1991, and the decline is continuing due to several factors including lack of initiatives and incentives and archaic outmoded oil technology. With the great historic changes currently sweeping the Soviet Union and Eastern Europe, communism will have less of an influ-

ence on world history. In the next five years, free enterprise will gain a foothold, and a dynamic overhaul will overtake their oil and gas industry; but the process will be a slow one because of entrenched bureaucratic systems. However, much aid will be provided by the West to help the Soviets overcome these obstacles.

With environmental terrorism, destruction of Kuwait oil facilities, severe economic sanctions against Iraq, decline in U.S. oil production, and significant decline in Soviet oil production, the question needs to be asked: How will these factors affect the price of oil?

Despite the contagious volatility of the oil-rich Middle East, oil and gas prices for the next five years will stabilize at a level beneficial to both consumers and producers alike. Oil prices between 1992 and 1996 will fluctuate $20–25/bbl. Even if a small regional war breaks out, any upward and immediate psychological market response will be short-lived.

Iraqi oil production of two million barrels per day will not be revived any time soon. Their oil facilities and their infrastructure have been heavily damaged. Their economy is in ruins. And, the embargo against Iraq could possibly continue until a change in their regime. So any Iraqi oil production will come under strict UN controls and will be initially about 50% of their OPEC quota. As for Kuwait, by mid-September 1991 it was producing only 260,000 bbl/d, compared to 2 million bbl/d prior to the invasion. This output is expect to reach 400,000 bbl/d by the end of 1991, and by mid-1992 it will go back again to the level of 2 million bbl/d.

OPEC oil production will be about 25 million bbl/d in 1992. Its influence on world oil markets has diminished substantially during the last decade. It will not regain the power it yielded in the decade 1973–1983. Over-production, North Sea oil, and other non-member production are major factors in this regard.

We would be amiss if we do not comment on the tremendous environmental impact on the oil industry. In the 1970s we witnessed the birth of an environmental decade. However, the gravity of environmental challenges led to making the final decade of the twentieth century, truly the environmental decade of the century. The U.S. Clean Air Act of October 1990 and other U.S. and international environmental legislation will have far-reaching consequences on the world economy and especially the oil and energy industry. Natural gas will fare well in this realm, since it is a cleaner fuel, but oil will remain supreme.

The oil industry will spend several billion dollars on environmental controls at refineries and other oil facilities. Combating oil spills will be a significant task. Oil companies will energize their economic and technological might. They will succeed in meeting the environmental challenges of this decade.

A bright future awaits the oil industry for the decade of the 1990s and way into the twenty-first century. Great opportunities will be harvested in the Middle East, the Soviet Union, and Eastern Europe.

While environmental matters will be of great importance to the oil industry, the good triangular but fragile balance between energy, environment, and economy (EEE) shall prevail way into the year 2000.

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INTRODUCTION

This appears to be a pivotal period for the worldwide oil and gas industry. The recent war in the Middle East resulted in some fundamental changes in political attitudes and alliances among the major petroleum producing countries. And these changes will substantially influence industry decisions and activity in these countries and worldwide for many years to come.

Changes in attitude concerning the impact of economic activity on the environment also are having an impact on the level and cost of activity in the energy industry. Concern for the environment has spread from the major industrial countries to most of the world. Environmental regulations are beginning to accumulate, and the combined impact is forcing the industry to make major investments and operating adjustments. This may prove to be the most important major influence on industry activity during the next 10 to 20 years.

Volatile and frequent changes have plagued planning for the worldwide oil and gas industry over the past several years. Whenever it appeared that the oil industry might become predictable, problems developed that made old projections obsolete and new forecasts uncertain. The worldwide and U.S. oil and gas industries have been shaped and reshaped by changing political and economic events.

The purpose of this *Oil Industry Outlook* book is to present the "most likely economic outlook" for the worldwide and U.S. oil industries during the next 5 years. This is done by reflecting on past and current economic events and projecting future trends in key parameters that measure activity in the industry. Assumptions are made about the political objectives of various key countries if they are related to economic objectives. No attempt is made to predict other political objectives and events because it is deemed impossible to make these predictions accurately.

There are almost an unlimited number of scenarios that could be constructed with respect to the various changes in the industry and their future impacts on the oil industry. What is presented in this book is the most likely scenario given economic theory, economic relationships, and a set of likely assumptions concerning future economic events.

Profitable long-term survival for many companies in the industry may still be dependent upon being aware of possible future changes and how they will shape the future. This outlook is being produced to provide some guidance and to assist in assessing the most likely route to the future.

In the past several years it was the overhanging surplus oil productive capacity in the world and OPEC that had the most influence over the level of prices and therefore influence over the level of activity in the industry. Many past outlooks tried to determine when this excess capacity would be eliminated and when the downward pressure on prices would be alleviated.

Last year, the surprise Iraqi invasion of Kuwait and the subsequent embargo of crude exports from these two countries temporarily eliminated the excess capacity and changed the economic conditions of the world oil market.

For a brief period the industry was changed dramatically. The oil price was sharply elevated. The higher product prices reduced demand for petroleum products. Total energy demand was reduced and economic growth slowed. This change lasted for only a short period. But the reduction in available production capacity has tended to stabilize the market and crude prices.

On the supply side a number of longer-lasting fundamental changes have occurred over the past year. The volatility in the industry appears to be leading toward the potential development of cooperation and possibly even alliances between producing and consuming countries. In addition, many OPEC countries have announced plans to increase production capacity in anticipation of growing future demand.

Crude oil from Iraq and Kuwait has not yet returned to the market in substantial volumes. But these two countries have huge

oil reserves. It is highly unlikely that these reserves will be removed from the equation that determines the world oil supply demand balance for much longer.

It appears that the level of worldwide productive capacity will again, in the near future, be the key element determining the outlook for the industry. The announced plans to increase productive capacity and the expectation of the return of Kuwait and Iraq crude oil to the world market are the most significant factors now determining the future of the industry. During the next year or two, the extent of the expansion of worldwide crude capacity will be clarified.

However decisions can not be delayed indefinitely; therefore, some projections of expected economic activity in the industry are essential. Even with today's uncertainty, an outlook must be developed to aid in decision making. And even with the uncertainty, these outlooks will have some value in the decision making process.

Change and uncertainty have been recurring themes in oil industry forecasts. They are not new to the oil industry. Anyone close to the oil industry will tell you that the only thing certain about the oil industry is change, uncertainty, and risk. In today's oil industry environment the entire foundation for making projections, forecasts, and decisions is unstable. About the only thing that is certain is that the future industry will not look like the past. And that means any new investment entails substantial risk – the risk inherent with change.

Forecasts are a valuable, essential tool for decision making. The "bottom line" for the forecasting industry is a better decision. The more information obtained to assist operating and investment decisions, and the clearer the understanding of potential future events that will affect the industry, the more likely that a decision will make a positive contribution to a company's performance. A decision is seldom, if ever, 100% right or wrong. The outcome is usually some gradation of right or wrong. Any information that can improve the decision and increase the overall return on the company's investment is a valuable addition.

Forecasts and projections can be useful tools that help reduce risk. But in order to be a useful tool, a forecast must be based on an understanding of recent events and their effect on the industry. The forecast must be internally logical and consistent, and it must use tried and tested economic theory as a framework.

All forecasts or outlooks are founded on a set of assumptions. It is essential that the basic assumptions used and conclusions drawn are logical and hold together based on an understanding of the industry. It is essential that they reflect the actual workings of the industry and the economic system of the industry.

The industry is changing, but the outcome is still determined by basic economic principles. Recent events may be shaping the future industry, but historical relationships should not be discarded. Political, non-economic events can upset the best forecast. But if a forecast is to be an aid in decision making, it must be based on known economic relationships rather than imagined future political events. This is also true in today's market when political events drastically change the economic relationships.

This outlook book has been developed to provide industry decision makers and analysts with a number of useful analytic tools. It is an outlook for the worldwide and domestic oil and gas industry for the next five years. It is a review of recent events that have had a major impact on the industry. And it is a guide to the factors to consider when preparing your own forecast for decision making.

In addition, the book provides the essential oil and gas industry historical data for additional individual analysis. This enables the adoption of an alternative set of assumptions and the development of alternative outlooks. Although a decision must be based on one perception of the future, a set of alternative assumptions and forecasts often aids decision making. Alternative outlooks can provide the framework for accessing the penalties or rewards from being

wrong about the future.

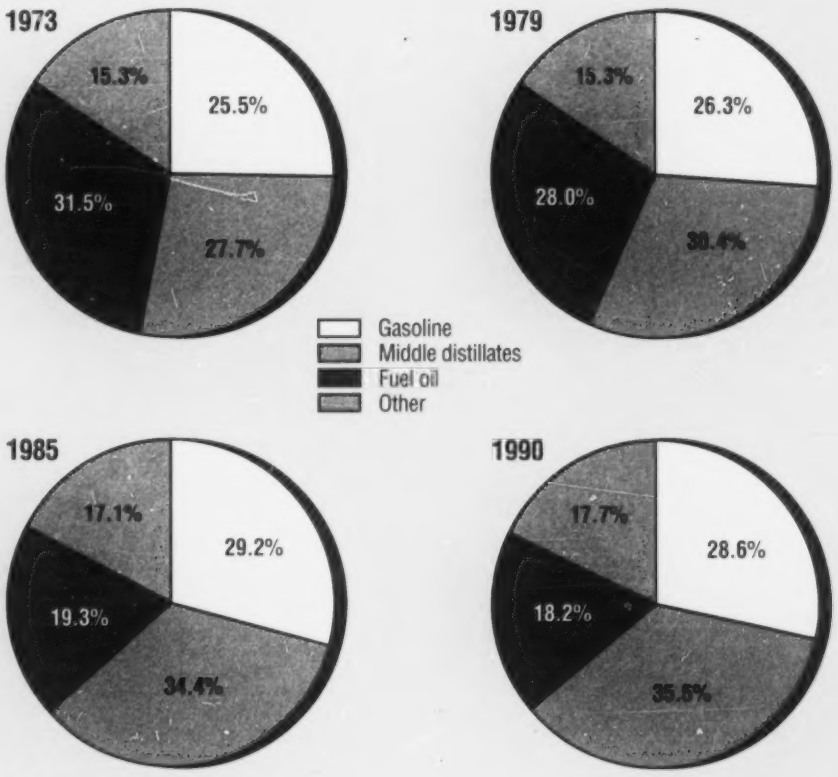
In order to operate profitably in the future, it is essential that companies develop a strategy for adapting to the changes occurring in the industry and a strategy for operating under the new conditions in the industry. The strategy that worked in the 1970s and 1980s will not necessarily work in the 1990s.

This outlook can be of assistance in clarifying recent events and trends and providing a logical and consistent outlook. The future may be filled with a great deal of uncertainty, but it is also filled with exciting opportunities. The only way to take advantage of those opportunities is to make the necessary decisions and take the risks. This book has been prepared to help reduce those risks and help make the decisions more profitable.

WORLDWIDE OUTLOOK—DEMAND

Worldwide energy demand has long been one of the key determinants of the outlook for all aspects of the worldwide oil and gas industry. And the level of demand is closely related to the level of economic activity and the expected growth during the forecast period. Petroleum is one of the primary sources of energy for economic activity. Therefore there is a direct relationship between the level of economic

WORLDWIDE* CONSUMPTION OF REFINED PRODUCTS BY MAJOR PRODUCTS



*Excludes Communist areas
Source: British Petroleum

activity, the level of energy demand to support that economic activity, and the level of petroleum demand to supply the energy required.

Worldwide petroleum demand has always been one of the major determinants of trends in the oil and gas industry. Economic forces generally determine the level of petroleum demand, but from time to time political considerations also have a great deal of influence in the oil market. An extreme example of this was the recent conflict in the Persian Gulf. Political events greatly influenced the oil markets before and after the hostilities.

Prior to the fighting, the fear of a potential supply shortage in a market that was deprived of oil from Iraq and Kuwait drove up the price of crude oil. A political/economic

decision to boost output in some of the OPEC countries with excess capacity helped to prevent market panic. Following the hostilities, the political decision by OPEC to produce near capacity helped to balance the market and stabilize prices.

Production decisions of this type by OPEC have had political overtones for some time. Quite often the decisions have proven to be very disruptive to oil markets and to economies depending upon oil as a basic fuel for economic growth. In the recent case of the Persian Gulf conflict, the political decisions tended to stabilize the markets.

In this section the initial focus will be on the recent trends in petroleum demand for the worldwide industry. These trends provide the background information needed to grasp the relationship between the many factors that influence worldwide oil demand. There are regional differences in oil industry activity throughout the world. But to a great extent the oil industry is a global rather than regional industry. In this chapter the recent trends and events in the industry will be expanded into a global outlook.

This global outlook is the required basis for creating any regional projections. The U.S., European, or any other regional oil industry is closely interrelated with activities in the worldwide industry. Any regional analysis must give consideration to the impact of worldwide economic and energy industry events.

Past trends in demand for petroleum products and the key factors that determine the level of petroleum product demand will be looked at in the first part of this section. These recent trends and relationships are important determinants of future product demand. Once the present situation in the industry has been established, it is followed by a presentation of the outlook for worldwide demand for energy and petroleum products for the next five years, 1992 through 1996.

The level of worldwide economic activity is still a major factor in determining demand for energy and oil products. Energy is an essential input for all types of economic activity. Therefore there is an extremely close relationship between economic activity and energy consumption. Although the relationship has changed over time, and has been rather volatile recently, as long as there is economic activity large quantities of energy will be consumed in some form. In today's modern economic systems with high levels of economic activity, vast quantities of energy are consumed, in a wide variety of forms and from many sources.

There are several basic energy sources, and two of the most important sources are oil and natural gas. Oil products and natural gas are consumed throughout the world in a variety of geographic areas with differing levels and types of economic activity. Oil products are consumed throughout the world, in the industrial economies, the developing economies, and in the centrally planned economies of the formerly communist countries.

In all areas of the world, demand for oil products and natural gas to fuel economic activity is the determinant of the level of activity in the oil industry. Therefore, energy needs and natural gas and petroleum product demand, throughout the world, have been analyzed as a basis for this outlook.

With the close relationship between economic activity and energy consumption, it becomes apparent that expectations for the future level of worldwide economic activity are still the key determinants of the future demand for oil and gas.

But the price of energy in general and the price of the individual forms of energy, such as oil and natural gas, also plays a major role in determining the level of demand. The relationship between economic activity and

energy consumption was altered dramatically over the past 10 to 15 years, because of the volatility of the cost/price of energy. The rapid increase in the cost of oil, and energy in general, broke the lock-step relationship between economic growth and energy consumption. With much higher prices for energy and petroleum products, conservation became a dominant factor determining the level of energy and oil consumption. The impact of conservation on demand was reduced in recent years as prices moderated. The ever-changing relationship between demand and price is reviewed in this section.

REVIEW

ECONOMIC ACTIVITY. Political actions will have a great deal of influence over worldwide oil and energy markets over the next few years. But the level of worldwide economic activity is still a key determinant of energy demand. Therefore, a review of recent trends in economic activity is appropriate in analyzing and establishing the current link between economic activity and energy consumption.

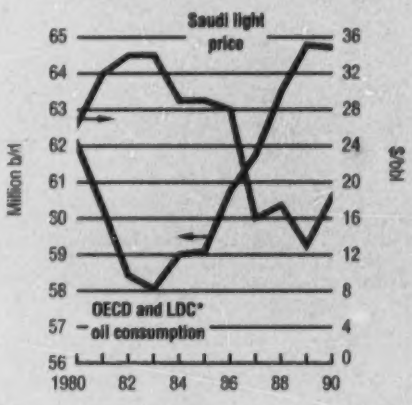
There is no aggregate measure of overall world economic activity. The statistics required to measure overall economic activity in many of the developing areas are not collected or even available. Only rough estimates can be made of the level of activity. There are some regional measures but mainly for the industrial countries.

Aggregate economic activity is measured for the countries in the Organization for Economic Cooperation and Development (OECD). This is a group of 24 industrial countries. Overall, economic activity for this group increased in 1987 after slumping for two years 1985–1986. The growth of real GNP/GDP moved up to 3.4% from 2.8% in 1986. The rate of growth increased to 4.5% in 1988 and then slowed to 3.3% in 1989 and 2.6% in 1990. The growth rate is estimated at 1.1% for 1991 but is projected to move up to 2.9% in 1992.

Lower energy prices can be given some credit for stimulating economic growth since 1986. However, even before the oil crisis in the Middle East, it was expected that the rate of economic growth would slow in 1990 and 1991. A recent report by the OECD gave estimated economic growth rates for the major industrial countries and the group as a whole. This report projected an economic slowdown in 1991 and a rebound in 1992. It did not project a recession or no growth year.

According to this report in 1988 Japan, Canada, Italy, United States, and United Kingdom, among the larger countries, led the way to higher growth for the OECD. Growth continued in 1989 but at a slower pace. Japan's growth rate moved up to 6.2% in 1988, from

WORLD OIL CONSUMPTION AND PRICE



*Organization for Economic Cooperation and Development, and lesser developed countries.

Source: British Petroleum and Energy Information Administration

4.5% the year before and only 2.4% in 1986. In 1989 Japan's economic activity grew at 4.7%, and it moved up to 5.6% in 1990. The growth rate was estimated at 3.5% in 1991. Canada posted a growth rate of 4.4% in 1988, compared to 4% in 1987 and only 3.2% in 1986. Growth slowed to 3% in 1989 and only 0.9% in 1990. A recession is estimated for 1991 and a decline of 1% in GDP. Italy had a 4.1% growth rate in 1988, up from 3% in 1987 and 2.5% in 1986. This fell to 3% in 1989 and to 2% in 1990. It is estimated at 1.7% in 1991. According to the OECD report, economic activity in the United States. moved up 4.5% in 1988 compared to 3.4% the year before and 2.8% in 1986. The rate fell to 2.5% in 1989 and only 0.9% in 1990. It is expected to be in recession in 1991 with GNP falling 0.2%. The United Kingdom posted a 4.2% growth rate in 1988. This was down from 4.6% in 1987 but higher than the 3.2% in 1986. The growth rate fell to 1.9% in 1989 and to 0.6% in 1990. The United Kingdom is also projected to be in recession in 1991 with GDP falling 1.8%. Germany's economic growth rate moved up to 3.7% in 1988 from only 1.8% in 1987 and 2.3% in 1986. This moved up to 3.8% in 1989 and 4.5% in 1990. It is projected to slow to 2.8% in 1991. France posted growth of 4.2% in 1988, up from 1.9% in 1987 and 2.3% the year before. The rate slipped to 3.9% in 1989 and 2.8% in 1990. This is expected to slow to 1.4% in 1991.

The group of smaller European countries had an aggregate economic growth rate of 3.3% in 1988, up from 2.9% in 1987 and 2.7% in 1986. This climbed to 3.5% in 1989 and then fell to 3% in 1990. It is estimated at 1.6% for 1991. Australia's growth rate dropped slightly in 1988 to 3.5% from 4.5% in 1987. But it was up from only 2.1% in 1986. The growth rate bounced back to 4.6% in 1989 but then slumped to 1.5% in 1990. GDP growth is projected to slow to only 0.2% in 1991. New Zealand's growth rate moved up to a positive 2.4% in 1988 after two years of recession, -0.1% in 1987 and -3.5% in 1986. The rate slipped to 0.2% in 1989 and then moved up to 1.2% in 1990. GDP is projected to fall 0.4% in 1991.

WORLDWIDE PETROLEUM PRODUCT MARKET SHARE

	1973 (%)	1976 (%)	1979 (%)	1982 (%)	1985 (%)	1990 (%)
U.S. and CANADA						
Gasoline	37.6	38.5	37.3	41.5	42.2	41.4
Middle distillates	25.2	25.7	27.0	26.9	28.7	29.6
Fuel oil	18.4	18.0	17.1	12.9	9.2	8.8
Other	18.8	17.8	18.6	18.7	19.9	20.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
WESTERN EUROPE and JAPAN						
Gasoline	17.2	18.5	19.4	21.5	23.0	24.3
Middle distillates	29.4	30.8	32.0	33.7	37.1	38.5
Fuel oil	40.5	38.4	35.4	29.7	23.3	20.2
Other	12.9	12.3	13.2	15.1	16.6	17.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
REST OF WORLD*						
Gasoline	19.1	18.6	19.0	19.7	20.2	19.6
Middle distillates	29.0	32.7	33.6	36.2	36.2	38.5
Fuel oil	37.8	34.6	33.9	30.1	27.0	26.2
Other	14.1	14.1	13.5	14.0	14.6	15.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
TOTAL WORLD*						
Gasoline	25.5	26.4	26.3	28.1	29.2	28.6
Middle distillates	27.7	29.2	30.4	32.0	34.4	35.5
Fuel oil	31.5	29.6	28.0	23.8	19.3	18.2
Other	15.3	14.8	15.3	16.1	17.1	17.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*Excludes communist areas

Source: British Petroleum

As can be seen there were wide ranging differences in the growth rates between the OECD countries in 1988 and 1989. But all but two, Norway (-0.5%) and Iceland (-0.8%), posted positive rates in 1988, and all but Iceland (-2.9%) were positive in 1989. In 1990 none of the countries had a negative rate but Finland posted no growth. The aggregate growth rate for these countries has moved up to a higher level in recent years, stimulated by the availability of lower-cost energy. However it should be noted that the internal cost of energy is determined by many factors and is not the same in each country.

The OECD economic growth rates for 1988, 4.5%, was considerably higher than the

long-term rate of about 2.5% per year. In 1989 the aggregate rate slipped to about the average at 2.6%, and in 1990 it fell even further to 1.1%. The rate of growth has not been very stable, and the OECD has gone through a number of economic cycles. The cost of energy has been responsible for some of the cyclical nature of that economic growth.

During the period of 1972 to 1982, aggregate real economic growth for the total group of countries averaged 2.5% per year. The most recent economic recession hit a trough in most of the industrial countries during the fourth quarter of 1982. Aggregate economic activity for the OECD dropped to 0.5% in 1982.

An upturn in economic activity started slowly in 1983. Real economic growth for the OECD group was 2.7% in 1983. The rate of growth accelerated in 1984, and the OECD total economic activity increased 4.9%. Economic growth slowed a bit in 1985 and 1986 with OECD aggregate activity up 3.2% and 2.8%, respectively.

The growth in the U.S. economy led the way in 1983 and 1984 as real U.S. GNP increased 3.6% in 1983 and 6.8% in 1984. But U.S. economic growth slowed to 3.4% in 1985 and to 2.8% in 1986.

Japan followed with an increase in economic activity of 3.2% in 1983 and 5.1% in 1984. Their growth slowed to 4.9% in 1985 and to 2.5% in 1986. Canada posted a rate of economic growth of 3.2% in 1983, 6.3% in 1984, 4.3% in 1985, and 3.2% in 1986.

The United Kingdom posted a slightly different pattern with a 1983 rate of 3.3%, 1984 -2.6%, 1985 -3.6%, and 1986 3.2%. Germany had a rate of 1.9% in 1983 that jumped to 3.3% in 1984, fell to 2.0% in 1985, and back up to 2.3% in 1986.

There are differences in the rates of growth and some differences in the cyclical patterns. But in general over this period there are striking similarities in the patterns of economic growth. Because of the increase in worldwide trade, the economic fortunes of all of the countries in the OECD appear to be closely related.

The rate of growth in economic activity for the entire OECD is estimated to be down to just 1.1% in 1991. The growth rate is estimated to be lower in all of the large major industrial countries, and several will be in recession. Economic growth is expected to rebound in 1992 to 2.9% as all of the countries post some growth. Part of the rebound is due to lower oil and energy costs in 1992.

The growth rate for the seven largest industrial countries was 3.3% in 1989, down from 4.7% in 1988. This dropped again in 1990 to 2.6%. The growth rate is estimated at only 1.1% for 1991 but projected to move up to 3% in 1992. The rate for the remaining group of OECD countries moved up in 1989 to 3.5% from 3.3% the year before. Growth for this group was down to 2.8% in 1990, slightly higher than for the major industrial countries. The rate is estimated at 1.5% in 1991, but it is projected to move up to 2.3% in 1992. These are the major industrial countries of the world. And it should be noted that industrial activity tends to be more energy intensive than many other aspects of economic activity, and therefore growth in these countries stimulates energy demand.

Economic growth in the developing countries is estimated to have slowed slightly in 1989 to 3.1%, from 4.4% the year before. The rate then slumped to 1.3% in 1990 and is estimated at 2.2% in 1991. The growth rate is projected to move up to 4.8% in 1992. Low oil prices and energy costs are particularly stimulating to economic growth in the developing countries. They do not have as many alternatives to help fuel their economies, and they do not have the funds to invest in energy conservation.

WORLDWIDE PRIMARY ENERGY CONSUMPTION AND MARKET SHARE

	1978	% of total	1979	% of total	1982	% of total	1984	% of total	1986	% of total	1988	% of total	1989	% of total	1990	% of total
							(Million barrels oil equivalent)									
Oil	21,217	46.0	22,907	45.0	20,461	40.6	20,693	39.1	21,252	38.2	22,377	38.9	22,772	38.8	22,733	38.6
Natural gas	8,398	18.2	9,405	18.5	9,746	19.4	10,585	2.0	10,901	19.6	12,029	20.9	12,509	21.3	12,740	21.6
Coal	13,086	28.4	14,431	28.3	14,998	29.8	15,946	30.1	16,993	30.5	16,118	28.0	16,227	27.7	16,068	27.3
Water power	2,627	5.7	3,058	6.0	3,361	6.7	3,614	6.8	3,787	6.8	3,856	6.7	3,883	6.6	3,963	6.7
Nuclear	770	1.7	1,121	2.2	1,794	3.5	2,137	4.0	2,761	4.9	3,190	5.5	3,279	5.6	3,380	5.8
Total*	**46,098**	**100.0**	**50,922**	**100.0**	**50,360**	**100.0**	**52,975**	**100.0**	**55,694**	**100.0**	**57,570**	**100.0**	**58,670**	**100.0**	**58,884**	**100.0**

*Excludes miscellaneous fuels not mentioned specifically.

Source: British Petroleum

WORLDWIDE OIL CONSUMPTION

Country/Area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/80	% change 90/85
						(1,000 b/d)							
North America													
U.S.*†	16,460	15,550	14,765	14,745	15,175	15,170	15,670	16,035	16,525	16,595	16,200	– 1.58	9.87
Canada†	1,855	1,760	1,565	1,475	1,425	1,490	1,475	1,515	1,590	1,660	1,615	– 12.94	9.49
TOTAL NORTH AMERICA	**18,315**	**17,310**	**16,330**	**16,220**	**16,600**	**16,660**	**17,145**	**17,550**	**18,115**	**18,255**	**17,815**	**– 2.73**	**9.83**
LATIN AMERICA	**4,615**	**4,660**	**4,765**	**4,680**	**4,645**	**4,645**	**4,755**	**4,985**	**5,080**	**5,275**	**5,400**	**17.01**	**15.38**
Western Europe													
Austria†	245	225	210	205	200	200	215	220	215	215	220	– 10.20	7.32
Belgium & Luxembourg†	540	500	475	435	420	430	485	490	500	500	495	– 8.33	13.79
Denmark†	275	260	225	215	210	220	215	200	195	185	180	– 34.55	– 16.28
Finland†	255	245	230	215	215	220	230	230	230	230	230	– 9.80	6.98
France†	2,260	2,060	1,915	1,880	1,815	1,790	1,830	1,845	1,830	1,875	1,875	– 17.04	– 0.27
Germany†	3,060	2,785	2,675	2,630	2,630	2,725	2,845	2,745	2,750	2,595	2,690	– 12.09	2.28
Greece†	250	240	240	230	235	245	250	270	280	305	295	18.00	26.26
Iceland†	10	10	10	10	10	10	10	10	10	15	15	50.00	50.00
Republic of Ireland†	120	105	95	85	85	85	100	85	80	85	90	– 25.00	5.88
Italy†	1,970	1,940	1,845	1,820	1,735	1,730	1,770	1,850	1,880	1,925	1,900	– 3.55	4.40
Netherlands†	800	745	655	625	625	635	700	705	740	735	745	– 6.88	19.20
Norway†	200	190	180	180	190	200	200	215	205	195	200	—	11.11
Portugal†	170	180	195	195	195	180	195	190	185	230	230	35.29	17.95
Spain†	1,070	1,040	990	1,010	955	925	925	945	970	1,010	1,040	– 2.80	2.97
Sweden†	500	455	420	375	360	375	385	355	340	325	320	– 36.00	– 14.67
Switzerland†	270	250	235	260	250	255	280	265	265	255	275	1.85	5.77
Turkey†	300	315	335	330	370	345	375	435	465	470	500	66.67	51.52
United Kingdom†	1,670	1,560	1,580	1,530	1,850	1,630	1,645	1,610	1,690	1,740	1,745	4.49	14.05
TOTAL WESTERN EUROPE	**13,965**	**13,105**	**12,510**	**12,230**	**12,350**	**12,200**	**12,655**	**12,665**	**12,830**	**12,890**	**13,045**	**– 6.59**	**6.66**
U.S.S.R. and Central Europe													
U.S.S.R.	9,065	9,155	9,095	8,970	8,980	8,950	8,995	8,985	8,885	8,765	8,145	– 10.15	– 9.20
Central Europe	2,000	1,890	1,805	1,765	1,765	1,790	1,890	1,865	1,865	1,885	1,620	– 19.00	– 8.22
TOTAL U.S.S.R. AND CENTRAL EUROPE	**11,065**	**11,045**	**10,900**	**10,735**	**10,745**	**10,740**	**10,885**	**10,850**	**10,750**	**10,650**	**9,765**	**– 11.75**	**– 9.04**
CYPRUS/GIBRALTAR/MALTA	**30**	**30**	**30**	**30**	**35**	**35**	**40**	**45**	**50**	**50**	**55**	**83.33**	**83.33**
MIDDLE EAST	**2,020**	**2,130**	**2,190**	**2,425**	**2,540**	**2,680**	**2,660**	**2,705**	**2,805**	**2,885**	**3,035**	**50.25**	**25.15**
AFRICA	**1,450**	**1,525**	**1,610**	**1,630**	**1,630**	**1,725**	**1,705**	**1,775**	**1,830**	**1,920**	**1,965**	**35.52**	**20.55**
Asia													
China	1,765	1,705	1,660	1,705	1,735	1,810	2,010	2,110	2,210	2,300	2,275	28.90	33.43
Indonesia	410	450	465	450	475	460	465	500	525	560	640	56.10	42.22
Japan†	4,935	4,695	4,395	4,390	4,620	4,435	4,495	4,500	4,805	4,990	5,255	6.48	19.70
Malaysia	160	170	175	185	185	185	180	180	190	200	220	37.50	18.92
Philippines†	215	205	195	205	170	150	160	180	195	225	235	9.30	14.63
Singapore	180	210	205	215	225	225	265	270	315	360	370	105.56	72.09
South Korea	485	480	480	505	510	515	570	605	720	830	1,020	110.31	101.98
Taiwan	285	270	270	300	315	330	375	395	475	515	540	89.47	80.00
Thailand	235	225	205	230	245	235	240	270	305	365	405	72.34	76.09
Other Asia	1,275	1,350	1,330	1,255	1,305	1,415	1,485	1,525	1,645	1,765	1,855	45.49	47.81
TOTAL ASIA	**9,945**	**9,760**	**9,380**	**9,440**	**9,785**	**9,760**	**10,245**	**10,535**	**11,385**	**12,110**	**12,815**	**28.86**	**35.75**
Australasia													
Australia†	630	625	610	590	610	590	610	635	650	675	685	8.73	16.10
New Zealand†	90	85	85	80	85	80	85	95	95	95	100	11.11	25.00
TOTAL AUSTRALASIA	**720**	**710**	**695**	**670**	**695**	**670**	**695**	**730**	**745**	**770**	**785**	**9.03**	**17.16**
TOTAL WORLD	**62,125**	**60,275**	**58,410**	**58,060**	**59,025**	**59,115**	**60,785**	**61,840**	**63,590**	**64,805**	**64,680**	**4.11**	**11.40**
OECD	**37,935**	**35,820**	**33,930**	**33,510**	**34,265**	**33,965**	**34,990**	**35,445**	**36,495**	**36,905**	**36,900**	**– 2.73**	**10.12**

*U.S. processing gain has been deducted from local domestic product demand. †OECD (Organization for Economic Cooperation & Development) member.

Source: British Petroleum

WORLDWIDE PRIMARY ENERGY CONSUMPTION

Country/Area	1980	1982	1985	1988	1989	1990	% change 89/80	% change 90/82
	(Million barrels oil equivalent)							
North America								
U.S.*	13,457.9	12,598.8	13,137.6	14,189.4	14,434.2	14,468.7	7.5	14.8
Canada*	1,657.3	1,575.2	1,633.1	1,802.4	1,817.8	1,751.1	5.7	11.2
TOTAL NORTH AMERICA	**15,115.2**	**14,174.0**	**14,770.7**	**15,991.8**	**16,252.0**	**16,219.8**	**7.3**	**14.4**
LATIN AMERICA	**2,564.8**	**2,704.8**	**2,883.6**	**3,197.3**	**3,323.4**	**3,447.3**	**34.4**	**27.5**
Western Europe								
Austria*	193.5	178.9	185.4	195.0	195.7	200.1	3.4	11.9
Belgium & Luxembourg*	370.2	337.9	352.6	379.7	390.0	383.4	3.6	13.5
Denmark*	142.9	121.7	134.9	131.9	120.2	117.3	−17.9	−3.6
Finland*	157.6	156.9	165.7	175.9	174.5	173.7	10.2	10.7
France*	1,387.6	1,332.6	1,381.7	1,444.7	1,482.9	1,501.9	8.2	12.7
Germany*	2,599.2	2,453.4	2,637.3	2,637.3	2,578.0	2,511.3	−3.4	2.4
Greece*	126.8	123.1	139.3	159.8	173.0	173.0	36.4	40.5
Iceland*	13.9	11.0	11.0	11.7	12.5	12.5	−10.1	13.6
Republic of Ireland*	62.3	60.1	61.6	64.5	58.6	59.4	−4.7	−1.2
Italy*	1,068.0	1,029.9	1,023.3	1,112.7	1,128.1	1,136.2	6.4	10.3
Netherlands*	540.2	496.2	510.9	544.6	544.6	544.6	0.8	9.8
Norway*	222.8	237.5	234.6	242.6	241.9	246.3	10.5	3.7
Portugal*	82.8	90.2	78.4	88.0	91.6	92.4	11.6	2.4
Spain*	560.7	554.9	571.0	609.1	647.2	661.2	17.9	19.2
Sweden*	351.8	338.6	392.2	389.2	377.5	371.6	5.6	9.7
Switzerland*	195.0	187.6	209.6	211.1	197.9	206.7	6.0	10.2
Turkey*	179.6	203.0	227.2	363.6	381.9	376.0	109.4	85.2
United Kingdom*	1,493.9	1,421.3	1,481.4	1,523.9	1,533.4	1,546.6	3.5	8.8
TOTAL WESTERN EUROPE	**9,748.8**	**9,334.8**	**9,798.1**	**10,285.3**	**10,329.5**	**10,314.2**	**5.8**	**10.5**
U.S.S.R. and Central Europe								
U.S.S.R.	8,304.2	8,638.4	9,446.9	10,188.0	10,124.9	9,862.5	18.8	14.2
Central Europe	2,720.9	2,537.3	2,753.9	2,858.7	2,814.7	2,490.0	−8.5	−5.6
TOTAL U.S.S.R. AND CENTRAL EUROPE	**11,025.1**	**11,275.7**	**12,200.8**	**13,046.7**	**12,939.6**	**12,352.5**	**12.0**	**9.5**
CYPRUS/GIBRALTAR/MALTA	**11.0**	**11.7**	**14.7**	**19.1**	**19.1**	**20.5**	**86.4**	**75.2**
MIDDLE EAST	**1,010.1**	**1,070.2**	**1,357.5**	**1,617.7**	**1,679.3**	**1,768.0**	**75.0**	**65.2**
AFRICA	**1,156.7**	**1,337.0**	**1,419.1**	**1,553.2**	**1,606.9**	**1,647.8**	**42.5**	**23.2**
Asia								
China	3,142.4	3,186.4	3,972.1	4,516.7	4,785.0	4,962.4	57.9	55.7
Indonesia	170.8	189.8	211.8	255.8	286.6	321.8	88.4	69.5
Japan*	2,635.9	2,499.5	2,744.4	2,966.5	3,078.6	3,193.7	21.2	27.8
Malaysia	67.4	71.8	94.6	118.7	131.9	144.4	114.2	101.1
Philippines	87.2	80.6	72.6	89.4	96.0	99.7	14.3	23.7
Singapore	69.6	78.4	86.5	120.9	138.5	142.9	105.3	82.3
South Korea	288.1	302.7	381.2	551.2	593.0	672.9	133.6	122.3
Taiwan	169.3	174.5	242.6	318.1	331.3	353.3	108.7	102.5
Thailand	90.2	93.1	118.0	167.1	188.4	214.8	138.1	130.7
Other Asia	1,359.7	1,482.9	1,683.7	2,008.4	2,120.6	2,217.3	63.1	49.5
TOTAL ASIA	**8,080.6**	**8,159.7**	**9,607.5**	**11,112.8**	**11,749.9**	**12,323.2**	**52.5**	**51.0**
Australasia								
Australia*	526.3	548.3	578.3	613.5	652.4	669.2	27.2	22.0
New Zealand*	82.8	84.3	97.5	116.5	118.0	121.7	47.0	44.4
TOTAL AUSTRALASIA	**609.1**	**632.6**	**675.8**	**730.0**	**770.4**	**790.9**	**29.8**	**25.0**
TOTAL WORLD	**49,321.4**	**48,700.5**	**52,727.8**	**57,553.9**	**58,669.2**	**58,884.2**	**19.4**	**20.9**
OECD	**28,109.1**	**26,540.9**	**27,988.9**	**29,973.8**	**30,430.5**	**30,518.5**	**8.6**	**14.6**

*OECD (Organization for Economic Cooperation & Development) member.
†Includes Australia and New Zealand

Source: British Petroleum

Although lower energy prices helped the oil-importing developing countries, they have had a less stimulating impact on the oil-exporting countries. Energy-exporting developing countries have, until recently, accounted for about 40% of the combined economic activity of the developing countries. The energy exporting countries had an average economic growth rate of about 6.6% from 1971–1980. But from 1981–1989 the growth rate averaged only 0.85%. Economic growth in these countries is estimated at only 1% in 1990 and a -1.5% in 1991. However it is projected to rebound to 7.9% in 1992. For the non-energy

exporting developing countries the growth rate was 4.9% in 1988 and an estimated 3.0% in 1989, 0.6% in 1990 and 1.4% in 1991. It is projected at 2.4% in 1992.

The depressing impact of huge budget deficits, huge worldwide debt, and growing protectionism has been offsetting the favorable stimulus of lower energy prices. All of the former factors tend to slow economic growth. However, if these factors are kept under control without stimulating another round of worldwide inflation, prospects for continued worldwide economic growth would be good.

A major key to economic growth is the level of investment. Investment can be stimulated if inflation is kept under control and the debt burden is managed properly, including a slow reduction in debt levels.

This outlook is based on the expectation that these problems will not be eliminated but will be controlled and the world economy will continue to expand.

ENERGY. The relationship between economic growth and energy changed markedly after energy prices skyrocketed in the 1970s and early 1980s. Price-induced conservation reduced energy consumption throughout the industrial world. This was more pronounced in the years following the 1978–79 oil price hike.

From a worldwide perspective, the effect of conservation on energy consumption was partially offset by continued growth in the developing areas. In developing areas, conservation of energy has not been as evident as in industrial areas. In the developing areas, industrialization is still the major economic policy objective and supersedes any attempts at conservation. But in these areas higher energy prices slowed economic growth and therefore also resulted in lower energy consumption.

There has been a shift in this trend during the past couple of years. The lower energy prices have helped slow conservation and the search for a more efficient use of energy. And the ratio of energy consumption to economic growth has moved up.

Over the long run, the ratio of energy to gross economic output can be expected to continue to fall worldwide, and particularly in the industrial areas. However, lower energy prices would slow conservation efforts and slow the rate of change in this ratio. This would be particularly true in those areas where lower energy costs are passed through to the user or consumer of energy.

World primary energy consumption has been on the rise in recent years. Total world primary energy consumption moved up 2.5% in 1986 to 54.1 billion barrels of oil equivalent. It moved up another 3.1% in 1987 to 55.7 billion barrels of oil equivalent, and then jumped up another 3.3% in 1988 to 57.6 billion barrels of oil equivalent. In 1989 and 1990 energy consumption increased again, up 2.0% to 58.7 billion barrels in 1989 and up 1.9% to 58.9 billion barrels in 1990.

World primary energy consumption moved up steadily through the 1950s, 1960s, and 1970s to 49.9 billion barrels of oil equivalent in 1979. During the 10-year span, 1969–1979, world energy consumption increased 51.6%, or at an average annual rate of about 4.2% per year. However, following the sharp increase in energy costs in the 1970s and early 1980s, a conservation effect was felt and energy consumption leveled off and fell. Energy consumption fell 2.4% between 1979 and 1982 to a recent low of 48.7 billion barrels of oil equivalent.

As energy prices began to slide, consumption increased, moving up steadily since 1982. Still lower energy prices and more vigorous economic growth helped boost energy consumption another 4.4% in 1984. It moved up in 1985, 2.4%, to 52.7 billion barrels.

Most of the energy conservation took

WORLDWIDE PETROLEUM PRODUCT CONSUMPTION

	1973	1976	1979	1982	1985	1988	1989	1990	% change 79/73	% change 90/79
				(Million barrels)						
U.S. and Canada	6,609.5	6,657.8	7,022.9	5,705.7	5,792.2	6,355.8	6,388.8	6,257.6	6.3	−10.9
Gasoline	2,487.8	2,565.5	2,619.0	2,366.1	2,441.6	2,641.0	2,637.3	2,589.7	5.3	−1.1
Middle distillates	1,663.2	1,712.3	1,893.3	1,537.1	1,663.9	1,853.8	1,874.3	1,850.8	13.8	−2.2
Fuel oil	1,214.6	1,201.4	1,198.5	737.4	534.4	609.1	612.1	553.4	−1.3	−53.8
Other	1,243.9	1,178.7	1,312.1	1,065.0	1,152.3	1,252.0	1,265.2	1,263.7	5.5	−3.7
Western Europe and Japan	7,461.9	6,954.0	7,181.9	5,945.4	5,768.0	6,106.6	6,185.8	6,324.3	−3.8	−11.9
Gasoline	1,285.7	1,285.7	1,396.4	1,276.2	1,326.7	1,474.1	1,504.8	1,534.2	8.6	9.9
Middle distillates	2,196.1	2,144.0	2,300.2	2,005.5	2,138.2	2,350.7	2,355.1	2,437.2	4.7	6.0
Fuel oil	3,023.6	2,668.1	2,545.0	1,765.1	1,341.4	1,255.6	1,274.0	1,277.6	−15.8	−49.8
Other	956.6	856.1	940.4	898.7	961.7	1,026.2	1,051.9	1,075.3	−1.7	14.3
Rest of World*	3,008.2	3,346.1	4,042.5	4,344.5	4,538.7	5,086.3	5,361.2	5,636.0	34.4	39.4
Gasoline	574.7	622.3	768.9	852.9	916.3	984.4	1,040.9	1,105.4	33.8	43.8
Middle distillates	872.3	1,093.6	1,356.8	1,574.5	1,731.3	1,950.5	2,075.9	2,172.6	55.5	60.1
Fuel oil	1,136.9	1,158.1	1,369.2	1,309.1	1,226.3	1,334.1	1,403.0	1,478.5	20.4	8.0
Other	424.4	472.1	547.6	606.9	664.8	817.3	841.5	879.6	29.0	60.6
Total World*	17,079.6	16,958.0	18,247.3	15,995.5	16,098.9	17,548.8	17,935.8	18,218.0	6.8	−0.2
Gasoline	4,348.2	4,473.5	4,784.3	4,496.2	4,684.6	5,099.5	5,183.0	5,229.2	10.0	9.3
Middle distillates	4,731.6	4,949.9	5,550.3	5,117.1	5,533.4	6,155.0	6,305.3	6,460.7	17.3	16.4
Fuel oil	5,375.1	5,027.6	5,112.7	3,811.6	3,102.1	3,198.8	3,289.0	3,309.5	−4.9	−35.3
Other	2,624.7	2,506.9	2,800.1	2,570.6	2,778.8	3,095.5	3,158.5	3,218.6	6.7	14.9

*Excludes communist areas Source: British Petroleum

place in the then non-communist countries.

During the period 1979 through 1982, energy consumption fell 4.3% in the non-communist countries. Over the same three-year span, energy consumption in the communist countries moved up 1.9%. With the extensive network of controls, world prices had a lot less impact on energy consumption in the countries with centrally planned economies.

Energy consumption in the non-communist countries began to move up again as prices moderated, increasing 0.6% in 1983. It moved up 4.4% in 1984, 1.6% in 1985, 2.1% in 1986, 3.5% in 1987, 3.9% in 1988, and 2.2% in 1989. From the recent low in 1982 through 1989, energy demand in the non-communist countries moved up 20.6%.

The conservation effect had the biggest impact on the industrial countries with energy-intensive economies. Between 1979 and 1983, U.S. energy consumption fell 10.2%, Western Europe energy consumption fell 8.1%, and Japanese energy consumption fell 7.8%. Most of these countries were highly dependent upon oil to fuel economic growth, and the huge increase in oil prices provided substantial incentive for conservation.

Even with moderately lower energy prices, growth in energy consumption has been modest in these industrial areas. But the rate of growth has been picking up in some of the areas. North American energy consumption moved up 5% from 1982–1986, then jumped up 3.5% in 1987, 4.2% in 1988, 1.6% in 1989, and fell 0.2% in 1990. Japan's energy use was up 5.7% in 1988, 3.8% in 1989 and 3.7% in 1990. It had moved up 10.4% from 1982–1987.

In contrast, Western Europe's energy consumption was up only 0.7% in 1988, 0.4% in 1989, and fell 0.1% in 1990. It had moved up 9.2% from 1982–1987. Many countries in Western Europe tax energy heavily, and any drop in energy costs is not always passed through to the consumer prices.

The combination of an increase in overall economic activity and low energy prices would boost energy consumption in the near future. Conservation will continue to dampen demand, but this would be offset by

the effect of lower prices and economic growth. Lower energy prices would severely diminish the incentive for conservation and boost energy consumption. Higher prices would lead to increased conservation and lower energy consumption.

There has been a substantial shift in the market share of the various forms of primary energy. During the period 1972 through 1983, oil's share of total worldwide primary energy fell from 46% to 40.3%. It then dropped to 39.1% in 1984 and 37.8% in 1985. Lower oil prices helped boost it back up to 38.2% in 1986. Oil's share slipped to 37.9% in 1987 but recovered to 38.9% in 1988. The share slipped in 1989 to 38.8% and in 1990 to 38.6%. The lower oil prices have slowed the decline in market share but have not stopped it completely.

Although there have been year-to-year fluctuations in relative market shares, all other primary fuels gained market share at the expense of oil during the period 1972–1985. The sharp drop in oil prices in 1986 and 1988 changed this trend slightly.

Natural gas moved up from 18.6% in 1972 to 20.0% in 1984 and to 20.1% in 1985. The natural gas share slipped to 19.6% in 1986 but then moved back up to 20% in 1987, 20.9% in 1988, 21.3% in 1989, and 21.6% in 1990. Coal increased from 28.9% in 1972 to 30.1% in 1984 and 30.6% in 1985. Coal slipped to 30.5% in 1986 and then to 30.1% in 1987, 28% in 1988, 27.7% in 1989, and 27.3% in 1990. Nuclear power supplied only 0.7% of total energy in 1972 but has moved up steadily since, to 4.0% in 1984, 4.6% in 1985, 4.9% in 1986, 5.2% in 1987, 5.5% in 1988, 5.6% in 1989, and 5.8% in 1990. Nuclear's increase has not been affected much by the rise and fall in oil prices. Hydroelectric power contributed 5.8% in 1972, 6.8% in 1984, and 6.9% in 1985. It slipped to 6.8% in 1986, moved back up to 6.9% in 1987, fell to 6.7% in 1988, and 6.6% in 1989. It moved up to 6.7% in 1990. Hydroelectric output is very dependent upon weather conditions and can be expensive and slow to develop.

The rapid rise in the price of oil relative to other fuels led to fuel switching. This was particularly true for heavy industry and electric utilities. With the high price, oil became the "swing fuel," supplying energy when other fuels were not available. Total world energy consumption was up 43.7% during the 1972–1988 period, while energy from oil was up only 17.7%.

The rapid rise in oil prices made the consumers, worldwide, oil energy cost-conscious. Where possible, fuel switching to less costly fuels took place. In general, energy costs had risen enough to become a major concern in the operating economics of industrial production and in the cost of living, and substantial price induced conservation took place.

The drop in crude prices in 1986 and 1988 made oil more competitive with other fuel sources and also slowed investment in conservation. If prices remain low in future years oil's share of the market may even increase, replacing coal or natural gas in certain areas.

OIL PRODUCT DEMAND. Worldwide non-communist demand for oil products has gone through three phases over the past 17 years. The world is changing rapidly, and the designation of non-communist and communist is rapidly disappearing. However, in the past, demand in the then non-communist areas followed two distinct trends between 1972 and 1983. From 1972 through 1979, free world demand was on the rise, increasing 15.8% over this 7-year span. From 1979 through 1983, demand for oil fell as price-induced conservation took over. Consumption dropped 11.8% over this 4-year time period.

The net effect was that free world demand in 1983 was only 2.2% above 1972.

There was a reversal of this downward trend in 1984 as lower prices and economic activity boosted demand 1.6%. Demand moved up only 0.1% in 1985, but then moved up 2.8% in 1986, 2.1% in 1987, 3.6% in 1988, 2.4% in 1989, and 1.6% in 1990.

This could signal the start of a new long-term upward trend in oil demand. Lower oil prices, particularly real oil prices adjusted for inflation, would combine with increased economic activity to boost demand throughout the near future.

A major factor lowering demand in the early 1980s was price induced conservation which brought about increased oil-energy efficiency. In addition, fuel switching, due to the higher oil prices, had an impact. They both helped to reduce overall demand for petroleum products and also changed the mix of petroleum products consumed. There was a shift to a higher percentage of light products since there was no convenient alternative energy substitute for these. The heavier fuel oils ran into a number of less costly substitutes that could be used — natural gas and coal being the major competing fuels.

The competition is most intensive for fuel for electric power consumption and for industrial production. Therefore, the impact of competitive fuels is most evident in the consumption of heavy fuel oil. Consumption of heavy fuel oil in the non-communist world was 5.1 billion barrels in 1979. Demand fell 38.8% to 3.1 billion barrels in 1985.

The high prices for heavy fuel oil led to increased consumption of coal and in some areas, natural gas. These fuels replaced high cost heavy fuel oil. In addition, the nuclear industry continued to grow, displacing demand for heavy fuel oil for electric power consumption. Sharply lower prices in 1986 proved that there is still a market for heavy fuel oil if the cost is competitive. Total non-communist consumption increased 2.7% in 1986 as low prices enabled heavy fuel oil to regain some market share from coal and natural gas. Prices moved back up in 1987 and demand fell again 3.4%. Prices fell in 1988 and demand increased 3.7%. Demand continued to move up again in 1989, 2.3%. Even though prices moved up in 1990, demand did increase, up a marginal 0.6%.

This consumption pattern was mainly due to demand in the United States. In the United States, heavy fuel oil consumption fell 58.1% between 1977 and 1985. But demand rebounded in 1986 moving up 18%. Demand slipped again in 1987, falling 10.9%. With prices lower again in 1988, demand moved back up 9.4%. Slightly higher 1989 prices led to lower U.S. demand in 1989, falling 3.2%. In 1990 demand responded to the economic downturn and to the sharply higher prices and fell 10.6%.

Demand for heavy fuel oil in Western Europe fell 50.5% between 1976 and 1985. But consumption moved up 0.5% in 1986 on the strength of economic growth and lower prices. Demand slipped 5.9% in 1987 as prices moved back up and then continued to slide in 1988, down 3.9%, and in 1989, down 1.4%. Consumption in Japan continued to slide throughout 1986 and 1987, down 5.1% and 3.6%. But in 1988 consumption reversed the trend and moved up 8.6%. The growth continued in 1989, up 1.9%. In 1990 demand slumped, down 1.6%, as economic activity slowed and prices moved up.

Lower fuel oil prices made fuel oil more competitive with other forms of energy. If prices of fuel oil remain competitive, there may actually be an increase in the demand for fuel oil in the future as the industrial countries look for a fuel source for increased electric power generation. The key to the level of demand will be the level of prices relative to other competing fuels.

WORLDWIDE OUTLOOK—DEMAND

The changing pattern of demand wasn't quite as dramatic for the other major petroleum products. Gasoline consumption in the non-communist world hit a high in 1978 at 4.8 billion barrels. With higher prices demand fell rapidly, 6.9% to 4.4 billion barrels in 1982. But as prices slipped and economic growth continued, demand moved up steadily from 1982 through 1990. Demand in 1990 was 5.3 billion barrels, up 16.3% from 1982. Demand in 1990 was 0.9% above 1989.

Demand in the United States also peaked in 1978 and then fell rapidly, 13% by 1982. Consumption in 1990 was down 1.9% from 1989 due to the economic recession. Demand in 1990 was up 10.9% from the recent low in 1982.

The pattern in Europe was similar. Gasoline consumption peaked in 1979 and then dropped abruptly, 9.1% by 1981. Demand has moved back up steadily since 1981. It moved up 1% in 1990 from the level in 1989 and was 17.2% above 1981.

In the developing countries, gasoline demand continued to climb steadily throughout the 1970s and 1980s with only a slight slip in 1983 and 1984 due to the high prices. In these areas demand moved up 7.0% in 1990 and was at a record high.

Middle distillate has been on the rise since 1982. Non-communist consumption increased 3.9% in 1986, 2.1% in 1987, 4.7% in 1988, 1.6% in 1989, and 2.5% in 1990. All five years set records surpassing the previous peak year of 1979. Middle distillate demand slid 8.6% between 1979 and 1982. But with increased economic activity and more reasonable prices, middle distillate demand has been increasing over the years since 1982.

Consumption of all other petroleum products moved up 2% in 1990, to 3.2 billion barrels. Demand in 1990 was at a new record high.

As can be seen, there has been a major shift in petroleum product demand to a larger percentage of lighter products. The major reason has been the reduction in demand for fuel oil. But in addition, demand for middle distillates, motor gasoline and other products, has moved up along with economic growth.

Demand for petroleum products in the non-communist world peaked in 1979 at 18.2 billion barrels. This fell 12.4% to 16.0 billion barrels in 1985. The drop in fuel oil consumption accounted for 89.6% of the decline.

Total demand in 1990 was down only 29 million barrels from the 1979 peak. Fuel oil demand in 1990 was down 1,803 million barrels, accounting for more than the entire decline.

From a geographical perspective, the shift in product mix is most pronounced in the United States, Western Europe, and Japan. In these areas there has been a major shift away from fuel oil and an increase in demand for gasoline and middle distillates. In the rest of the free world, the shift has not been as pronounced but is also evident.

During the period 1977 through 1989, the product demand mix changed markedly. In the United States the fuel oil share of the total barrel dropped from 18.6% in 1977 to 8.5% in 1990. Gasoline moved up from 38% in 1977 to 41.9% in 1990. And middle distillates increased from 25.9% to 29.5% in 1990.

In Canada the fuel oil share slipped from 18.5% to 12% in 1990. But fuel oil consumption had been lower and increased 22.2% in 1989 before falling only 0.6% in 1990. Gasoline consumption increased from 34.8% in 1977 to 35.7% in 1990. And the middle distillates share has remained fairly constant at 31.3% in 1977 and 31.0% in 1989.

In Western Europe and Japan the drop in fuel oil demand was even more pronounced. In Europe fuel oil demand dropped from 32.4% of the market in 1977 to 17.7% in 1990. Gasoline in Europe moved up from 19.1% to

25.5% in 1990. And middle distillates shifted from 35.3% to 40.1%. In Japan fuel oil fell from 49.5% of oil product consumption in 1977 to 26.6% in 1990. Gasoline moved up from 17.1% to 21.1%, and middle distillates increased from 21.4% to 34.7% in 1990.

There are obvious geographical differences, with gasoline being a much greater share of the North American market and fuel oil relatively more important but diminishing in importance elsewhere.

Looking at product consumption from the geographical perspective, what also stands out is the difference in trends between the industrial countries and the other, less developed, countries (LDCs).

Total major product consumption in the United States, Canada, Western Europe, and Japan dropped 11.4% from 1979 through 1990. For the remainder of the non-communist world, consumption in 1990 was up 39.2% from 1979.

PRICES. There was an abrupt alteration of the relationship between economic activity and energy consumption starting in the 1970s. This alteration was primarily due to the rapid increase in the cost of oil and other energy in the 1970s.

Oil and other energy costs increased more rapidly than other economic costs. This made energy cost a more important consideration in business decision making. The result was an adjustment in investment decisions with more concern for cost-cutting and energy-saving investments.

This shift altered the emphasis of investment decisions—from investing for increased economic output for consumption, to an emphasis on energy cost cutting. This contributed to a drop in energy demand but also slowed worldwide economic growth.

From 1972 to 1982, the posted price of Saudi Arabian marker crude increased from $2.48/bbl to $34/bbl, an increase of 1,271% or $31.22/bbl. The real price adjusted for inflation increased 546%. This far surpassed the average price increase for all commodities of 151% during this period.

The sharp increase in prices did not initially slow demand for petroleum products. There is some evidence that the price of crude oil was held below the market equilibrium price in the 1960s. This made oil cheap relative to other items and this stimulated demand. Therefore, the initial 1973–74 increase in oil prices was relatively easily absorbed by the economy.

Another reason that demand did not appear to react to the initial price increase was that many energy and oil conservation investments take time to exert a measurable impact. In the industrial, utility, and residential/commercial sectors, it may take up to 10 years or more before the majority of the impact from conservation investment is felt.

The time it took to adjust to the price shock varied in the different economic sectors. In the electric utility and heavy industry sectors, the total adjustment was slower although still dramatic. In these sectors conservation or fuel switching often requires a substantial capital investment.

On the other hand, adjustment to price changes can be very rapid in the transportation sector of the economy. Much of the conservation is in the form of a change in discretionary driving habits. But there are also fewer substitutes for petroleum products in this sector and therefore limits on fuel switching. This can offset some of the potential impact on energy demand from higher prices.

Current dollar prices leveled off after the initial price shock of 1973–74, and the real inflation-adjusted price fell. This muted the

conservation adjustment to this price hike.

The 1979–80 price boost produced a much more dramatic adjustment. That price jump coupled with forecasts of future rapidly rising oil prices led to a sharp drop in oil consumption.

Between 1978 and 1981, the world price of oil jumped another 152%. Responding to this rapid increase in prices, the demand for oil in the non-communist world peaked in 1979 and dropped 12.3% by 1983. During this 4-year period, the worldwide demand response to the price increase was a 0.9% drop in demand for every 10% increase in price. This is a relatively inelastic demand. But it did show that there was a demand response to price that must be considered when estimating demand for oil products.

The drop in oil demand as a response to prices, and the worldwide economic slowdown, put downward pressure on crude prices in the early 1980s. When demand fell sharply, a massive crude production capacity surplus developed. The surplus led to intense price competition in the oil market. And the result was a peaking of crude prices in March 1981. Although the official price of the OPEC marker Saudi light crude was boosted to $34/bbl in 1982, actual average transaction prices for crude oil traded were beginning to fall in March 1981.

The Saudi light crude marker price was lowered to $29 in early 1983, and again to $28 at the beginning of 1985. This was a 17.6% drop in the official marker crude price. The drop in actual transaction prices was even greater as more and more crude oil was being traded based on spot market prices.

Initially the lower crude oil prices had a small positive impact on demand in the non-communist countries. Demand moved up 2.0% in 1984 but slipped 1.1% in 1985. It should be noted that the strong U.S. dollar at that time relative to other currencies resulted in oil prices being higher outside the United States. Export crudes, particularly from OPEC, are denominated in U.S. dollars. Therefore in several European countries, oil prices, and petroleum product prices, had actually risen from 1981 to 1985. That tended to suppress demand for petroleum products in Europe and other areas and was a major reason why the demand response wasn't greater worldwide.

Prices were prevented from falling even more rapidly in the 1981–1985 period by the willingness of Saudi Arabia to support prices through a reduction in their production level. But there was a limit to the extent Saudi Arabia would support prices.

One of the most significant recent pricing events occurred in late 1985. Saudi Arabia became alarmed when their production fell below 2 million bbl/d, playing the role of swing producer to prop up prices during declining demand for OPEC oil. They were not getting cooperation from other OPEC countries in cutting production to support prices.

So Saudi Arabia abandoned their role of crude exporter of last resort or swing producer in the fall of 1985 and decided to concentrate on maintaining a "fair share" of the market. They adopted a net-back pricing scheme that enabled them to recapture a substantial share of the export market for crude oil.

OPEC, in December 1985, adopted a similar policy objective of capturing world market share by price competition. These two moves flooded the world market with excess oil and created more downward pressure on prices.

As soon as the winter demand for oil slackened in January 1986, prices began to plummet. The average worldwide price of exported crude oil fell from $27.10/bbl the first week of January 1986 to $9.35/bbl the first week of August 1986. This was a drop of

$17.75/bbl, 65.5% in seven months. This forced OPEC to put together an informal quota agreement effective in September 1986. And that helped prices move back up to $13–14/bbl throughout the remainder of 1986. A formal OPEC quota agreement followed in December and helped push average export prices up over $17.50/bbl in 1987. Futures market prices which are based on one high grade of light sweet crude moved over $20/bbl.

As mentioned, oil product demand is relatively price inelastic. But a drop in price of the magnitude that occurred in 1986 is sure to have a stimulative impact on demand and offset some conservation. As a result, non-communist world demand for petroleum products moved up 3.3% in 1986. Demand in the United States moved up 3.5%. Demand in Western Europe moved up 4% in 1986. Even in Japan where oil conservation is a major economic objective oil demand moved up 0.9% in 1986.

Prices moved back up in 1987 but were still much lower than in the recent past. And this relatively low price level had a mildly stimulative impact on demand. Total non-communist demand increased 2% in 1987.

Prices slipped again in 1988 due to OPEC overproduction. Although OPEC has a quota system in place, a number of the member countries, notably Iraq and the UAE, refused to adhere to the quotas and boosted output. This overproduction weakened prices, and by October 1988 crude prices had dipped close to the low level of 1986. This tended to restimulate demand, and non-communist consumption moved up 3.9% in 1988.

Prices in 1989 were very similar to 1987, holding relatively constant as OPEC managed to hold production close to a market clearing level. Prices in 1989 were up about 25% from the year before, and this tended to somewhat dampen the increase in petroleum product demand. But demand in the non-communist areas did move up 2.2%, primarily due to growth in the developing countries.

The crisis in the Middle East at the end of 1990 pushed prices up sharply. Worldwide average export crude oil prices moved up to $21.35/bbl in 1990, an increase of 28.2%. Even with the price hike product consumption in the OECD and developing countries moved up 1.6% in 1990. Again the increase was located mainly in the developing countries where demand increased 5.3% in 1990.

During the past five years there has been a price cycle developing that is driven by OPEC production. This may have been changed temporarily because of the outcome of the war in the Persian Gulf. Over those years there was a tendency on the part of the OPEC cartel to overproduce the production quotas they set. There was apparently some tendency for the individual OPEC countries to compete for market share when demand began to rise. This led to production well above the quota level set by OPEC to balance market supply and demand.

The excess production put downward pressure on prices. When prices fall to a level that the OPEC countries felt was unacceptable, a new quota agreement was reached. Then some production discipline is practiced by the overproducing countries for a period of time, and prices move back up closer to the OPEC target level.

However at the relatively low price levels that have prevailed, demand continues to move up and market share competition starts up again. And the cycle starts to repeat itself.

The recent crisis in the oil producing areas of the Middle East may have substantially altered conditions and temporarily eliminated the cycle. Under current conditions there is very little excess capacity in OPEC. Therefore overproduction is not a major problem. As a result prices have been reasonably stable for an extended period.

OUTLOOK

At the present time conditions look favorable for continued growth in the worldwide demand for oil products over the forecast period. Oil markets have settled down after the upheaval caused by the Persian Gulf conflict. In fact, crude oil prices on the world markets have gone through a period of stability that hasn't been experienced since the early 1980s.

The reduction in worldwide crude oil capacity as a result of the outcome of the Persian Gulf war has enabled OPEC to balance supply and demand in the market at a price level that appears attractive to consumers as well as many OPEC members.

These market conditions may not last for an extended period. There are strong indications that substantial crude oil production capacity will be added to the market in the next few years. However, the changes in the market caused by the additional crude oil capacity should be favorable to consumption. The additional capacity will put downward pressure on prices if it rises substantially faster than demand. And lower prices tend to encourage consumption.

The stable current conditions in the market are quite different than the conditions at the end of 1990. The invasion of Kuwait by neighboring Iraq in early August 1990 had a substantial impact on the demand/supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million bbl/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and Kuwait's lost production removed close to 4.2 million bbl/d in exports from these two countries. In addition, 300,000 bbl/d of production from the Kuwait share of the Neutral Zone was affected by these events also.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion but moved up sharply after. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

One of the more significant actions that occurred during the upheaval was the increase in production capacity by Saudi Arabia and several other major OPEC producers. The increase in capacity prevented really severe shortages from occurring and prevented total chaos in the market. The additional capacity has also allowed the current stability in the market at a moderate price level.

The stability will not last forever. Even at existing capacity levels there will be some price movement. It is quite likely that prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. The added capacity in Saudi Arabia and elsewhere has alleviated part of the problem. But as long as that production remains shut-in, the crude oil market will be tight, with little contingency production capacity available. Prices will be higher than if this capacity was available to the market.

Following are the highlights of what is projected to happen with respect to worldwide demand during the forecast period.

Base Scenario — Prices have been stable since the end of the war in the Persian Gulf. Production from Iraq and Kuwait has not returned

to the market. Kuwait's production capacity was set ablaze by fleeing Iraqi troops. And the U.N. embargo on oil exports from Iraq has remained in place. Offsetting this lost production has been increases in capacity and production in Saudi Arabia and several other major OPEC producers. The net loss in worldwide production capacity was an estimated 4.8 million bbl/d in 1991. Estimated excess capacity fell 4.3 million bbl/d.

Prices jumped up in 1990 due to the fear of supply disruptions caused by the potential conflict and the lost capacity. The average worldwide price of export crude oil jumped 28.2% to $21.35/bbl. The price fell sharply when it became apparent that there would not be supply disruptions or shortages. In addition, the willingness of OPEC to increase capacity and produce at a level that keeps the market in balance stabilized prices at a lower level than 1990. The estimated average worldwide export prices of crude oil for 1991 is $17.80/bbl, down 16.6%. The price stabilized at a level slightly above the average $16.65/bbl in 1989.

It is expected that substantial production from Iraq and Kuwait will return to the market in 1992. In addition, some of the other OPEC countries will boost production capacity. As a result of this worldwide crude oil production capacity will move up 4.6 million bbl/d in 1992. Excess capacity will move up 4 million bbl/d. The additional excess capacity will put downward pressure on prices. The average worldwide price of export crude oil will fall to $17/bbl in 1992.

This will be repeated in 1993 as capacity continues to move up slightly faster than demand and the downward pressure on prices intensifies. The average price of world export crude oil will fall to $16/bbl in 1993.

During the remainder of the forecast period, demand will move up slightly faster than capacity, and the level of excess production capacity will be reduced. As a result prices will move up, increasing to $20/bbl in 1996. Over the forecast period the average price of world export crude will move up only $2.20/bbl, 12.4% from the 1991 level.

It is expected that inflation will average about 3%/year during the forecast period. The modest rise in crude oil prices will mean that the real price of crude will remain fairly constant and may even decline. This would be very stimulative to petroleum product demand. However, this is consistent with one of the key objectives of the OPEC countries with large reserves.

It is expected that OPEC will continue to be a major factor in determining the worldwide prices for crude oil and therefore the worldwide demand for petroleum products. It is also expected that the OPEC countries with the largest reserves will have the most influence in setting OPEC target prices. OPEC's policy will again be to establish a market clearing production level that will result in a targeted price for their exported crude oil.

In the past, OPEC's inability or unwillingness to keep its production in line with the selected quota and product demand was the major reason for the volatility in prices. And price volatility had an impact on product demand. This problem may plague OPEC and the oil market again, but it is expected that there will be more production discipline.

The level of economic activity will still be one of the major factors determining the level of energy demand and petroleum product demand. But the cost of energy is the factor determining the effort given to conservation. And the relative price levels greatly influence the type of energy that will be used to fuel the economic growth. Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelat-

ed and interdependent.

There are still a number of major problems that plague the worldwide economy. The major problems are the huge international debt, large budget deficits, rapid population growth, and unemployment. And there is a growing threat that a wave of protectionism may sweep over the industrialized areas and reduce world trade. Any and all of these could slow worldwide economic growth.

These problems are being contained at the present time. And it is not anticipated that they will cause a recession during the next five years.

For 1991, economic growth in the OECD countries is estimated to have slowed to about 1.1%. In the developing countries the growth rate is estimated at 2.2%, while in the USSR and Eastern Europe a decline of 4.1% in economic activity is estimated.

It is projected that the growth rate in the OECD countries will move up to 2.9% in 1992. In the developing countries this will move up to 4.8%, but in Eastern Europe and the USSR economic activity will decline another 2.2%. Lower oil and energy prices should provide some stimulus for accelerated growth.

In 1993 the economic activity growth rate for the OECD countries is projected to move up to 3.2%. In the developing countries this will move up to 4.9%, and in the USSR and Eastern Europe there will be positive growth of 1.5%. Again low oil and energy prices should help boost growth.

During the remainder of the forecast period, economic growth in the OECD countries is expected to average about 3.1% but slowing just a bit by 1996. A similar pattern is expected in the developing countries but the average annual growth rate will be about 4.8%. In Eastern Europe and the USSR economic activity is projected to be on the upswing, and growth should average 4% per year over the 1994-1996 period.

Relatively low energy prices are expected to be a positive stimulus to economic activity throughout the forecast period. There are a number of other events that also could give a positive stimulus to economic growth during the next five years. The establishment of the new economic rules for the European community in 1992 is expected to boost trade and economic activity. And the recent events in Eastern Europe and the USSR could eventually result in the development of more vigorous economies with great growth potential. The relatively low oil prices and increased economic activity is expected to also stimulate demand for petroleum products. And this in turn will enable a gradual price increase during the later years. All of these elements are interrelated.

Looking at the long term historical relationship of energy consumption to economic growth, it is expected that energy conservation will continue to some degree throughout the forecast period. Therefore the growth in energy demand will track the rate of growth of economic activity but at a slower rate. However, during the years of relatively low energy prices it is expected that the ratio of energy growth to economic growth will be greater than in the recent past. With low cost energy there is not as much incentive to invest in conservation. Instead, energy is used more liberally to fuel economic growth.

During the years of low cost energy, investment in energy conservation will be lower than in past years, but it is still expected to continue to move up. There is now a great deal of concern about the impact of energy consumption on the environment. Therefore there will be a lot of pressure in the industrial world to improve on energy consumption efficiency.

Growth in energy consumption will follow growth in economic activity, and the pattern for rate of energy growth will be similar to that outlined for economic growth. With lower oil and energy prices in 1992, economic growth will accelerate and the rate of increase in energy consumption will increase. This will be particularly pronounced in the industrial OECD and developing countries. When oil prices fall in 1992 and 1993 the rate of growth in economic activity will increase and so will the rate of growth in energy consumption. Total worldwide demand for energy is projected to be up 13.4% in 1996, at the end of the forecast period. The rate of increase will be higher in the developing countries where energy consumption is expected to be 22.6% higher in 1996.

In the past there has been greater incentive to increase energy efficiency in the market economies than in the communist world. However, the former communist countries are now adjusting their economies and creating market oriented systems. As this transition gains momentum these economies will begin to use energy more efficiently. The rate of energy growth in those areas could be slowed due to a low rate of economic growth due to adjustment problems or the development of more energy efficiency.

The relatively low current and real oil prices and petroleum product prices will help stimulate the worldwide demand for oil. And the rate of increase in oil demand will move up close to the rate of increase in overall energy demand. Oil consumption conservation also is expected to continue throughout the forecast period, but with lower energy prices the incentive is greatly reduced. With low prices oil will be much more competitive with other fuels and will be able to retain or regain a good portion of its present share of the total energy market.

Demand for all major types of petroleum products, including fuel oil, are expected to increase over the forecast period. One of the things that will stimulate demand for petroleum is the growth in electric power consumption worldwide. At the lower prices, fuel oil will play the role of swing fuel for electric utilities and heavy industry and demand will increase.

During the five-year forecast period 1991–1996, world oil demand is projected to increase 9.6% to 70.475 million bbl/d in 1996. This is an increase of 6.2 million bbl/d. OECD oil demand is expected to increase 7.6% to 39.895 million bbl/d in 1996. This will be an increase of 2.805 million bbl/d. Demand in the developing countries will increase 17.2% to 21.4 million bbl/d. This will be an increase of 3.135 million bbl/d. The rate of increase in demand will slow a bit later in the forecast period due to energy conservation and environmental concerns. However demand will remain strong in the developing countries where there are few alternatives to oil. Therefore the growth in oil demand will not slow as much as might be expected. Demand will remain closely related to economic growth and the growth in total energy consumption.

In the areas covered by the OECD and developing countries, demand for all major products is expected to increase over the forecast period. Low prices over the forecast period should even boost demand for heavy fuel oil. Fuel oil will be much more competitive with other fuels than in years of high oil prices. Growth in demand for fuel oil is not projected to be as rapid as for some other petroleum products. However the growth could be greater worldwide if there is any slowing in completion of nuclear facilities, or if coal usage is curtailed due to "acid rain" and other environmental concerns. These issues are becoming important global issues. They may prove to be more important determinants of oil demand in the future than the situation in OPEC and the Middle East.

WORLDWIDE DEMAND

KEYS TO THE FUTURE

1. OPEC and worldwide production capacity will move up sharply in 1992 and 1993. Capacity will continue to move up during the entire forecast period 1992–1996. Several major OPEC producing countries, particularly Saudi Arabia, will boost production capacity. In addition, production will be resumed from Kuwait and will move up to close to previous levels during the forecast period. The embargo on exports from Iraq will be relaxed and eventually eliminated. This will restore the massive production capacity of these two countries to the world oil market. The additional capacity will put downward pressure on prices throughout the forecast period. The OPEC cartel will continue to have a great deal of influence over the worldwide oil industry. It is likely that the OPEC countries with large reserves will dictate oil policy. But with the increase in capacity OPEC will continue to have problems with controlling the overall production level.

2. With the substantial downward pressure due to growing worldwide excess capacity, prices will fall in 1992 and 1993. Prices will fall 10% to an average $17/bbl in 1993. The extent of the price slide will depend upon the ability ofOPEC to maintain some production discipline as capacity grows and particularly when production from Iraq and Kuwait are resumed. It is felt that OPEC will show some production discipline, primarily through the leadership of Saudi Arabia. The increased capacity in Saudi Arabia should give them additional influence in setting production and price policies. The drop in prices will be due to the return of substantial worldwide excess production capacity. It is expected that in the latter years of the forecast period prices will move up gradually along with increased demand for petroleum products. The average world export price will move up to $20/bbl in 1996.

3. The United States and other countries are expected to move out of the recession and resume economic growth in 1992. Growth will be stimulated by lower oil and energy prices. The rate of economic growth in the OECD industrial countires and in the developing countries will accelerate in 1993. Europe 1992 is expected to give the worldwide economy a boost. The development of market economies in the USSR and Eastern Europe will initially be very disruptive to these economies. In these areas economic activity is expected to decline in 1991 and 1992, before moving up marginally in 1993. The continuation of relatively low oil and energy prices is expected to stimulate economic growth in all areas for the remainder of the forecast period. Major problems with international debt, large budget deficits, unemployment, etc., will be contained. Population and environmental problems are expected to grow in importance.

4. The relatively low oil and energy prices are expected to dampen the incentive for investing in energy conservation. There will be continued improvement in energy consumption efficiency, but the rate of improve-

THE OUTLOOK — WORLDWIDE DEMAND

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
WORLD ENERGY DEMAND									
(million barrels oil equivalent)									
OECD countries (OECD)	30,520	30,705	31,240	31,840	32,400	32,955	33,500	+2,795	+9.1
Developing countries & China	16,011	16,310	17,015	17,765	18,565	19,320	19,990	+3,680	+22.6
U.S.S.R. and East Europe	12,353	11,845	11,585	11,760	12,230	12,720	13,230	+1,385	+11.7
Total	**58,884**	**58,860**	**59,840**	**61,365**	**63,195**	**64,995**	**66,720**	**+7,860**	**+13.4**
WORLD OIL DEMAND									
(Total product demand)									
(thousand barrels/day)									
OECD countries (OECD)	36,900	37,090	37,630	38,235	38,795	39,350	39,895	+2,805	+7.6
Developing countries & China	18,015	18,275	18,885	19,530	20,210	20,850	21,410	+3,135	+17.2
U.S.S.R. and East Europe	9,765	8,910	8,490	8,690	8,870	9,040	9,170	+260	+2.9
Total	**64,680**	**64,275**	**65,005**	**66,455**	**67,875**	**69,240**	**70,475**	**+6,200**	**+9.6**
PETROLEUM PRODUCT DEMAND									
OECD and developing countries									
(thousand barrels/day)									
Gasolines	16,551	16,635	16,850	17,080	17,310	17,530	17,745	+1,110	+6.7
Middle distillates	18,465	18,650	19,120	19,640	20,155	20,655	21,100	+2,450	+13.1
Fuel oil	8,308	8,365	8,510	8,670	8,825	8,975	9,120	+755	+9.0
Others	8,079	8,175	8,420	8,680	8,940	9,190	9,425	+1,250	+15.3
Total	**51,403**	**51,825**	**52,900**	**54,070**	**55,230**	**56,350**	**57,390**	**+5,585**	**+10.7**
CRUDE OIL PRICE									
(Average world export price)									
($/barrel)	21.35	17.80	17.00	16.00	17.50	18.50	20.00	+2.20	+12.4

ment will be slower. Worldwide energy consumption will be up 13.4% in 1996 at the end of the forecast period. Consumption in the developing countries will move up 22.6%.

5. The increased level of economic activity and relatively low oil prices will help stimulate demand for petroleum products. World demand for petroleum products is expected to increase during the forecast period. The rate of growth will be somewhat higher in 1992 and 1993 due to the lower prices. The growth rate in the developing countries will be much greater than in the industrial areas. Worldwide oil demand will be up 9.6% in1996 at 70.5 million bbl/d.

OUTLOOK 2000 — WORLDWIDE DEMAND

	1990	1995	2000	Change 1990 to 1995	Change 1995 to 2000	Change 1990 to 2000	% change 1990 to 1995	% change 1995 to 2000	% change 1990 to 2000
WORLD ENERGY DEMAND									
(million barrels oil equivalent)									
OECD countries (OECD)	30,520	32,955	35,765	+2,435	+2,810	+5,245	+8.0	+8.5	+17.2
Developing countries & China	16,011	19,320	22,235	+3,309	+2,915	+6,224	+20.7	+15.1	+38.9
U.S.S.R. and East Europe	12,353	12,720	14,745	+367	+2,025	+2,392	+3.0	+15.9	+19.4
Total	**58,884**	**64,995**	**72,745**	**+6,111**	**+7,750**	**+13,861**	**+10.4**	**+10.7**	**+23.5**
WORLD OIL DEMAND									
(Total product demand)									
(thousand barrels/day)									
OECD countries (OECD)	36,900	39,350	41,150	+2,450	+1,800	+4,250	+6.6	+4.6	+11.5
Developing countries & China	18,015	20,850	22,575	+2,835	+1,725	+4,560	+15.7	+8.3	+25.3
U.S.S.R. and East Europe	9,765	9,040	9,760	−725	+720	− 5	−7.4	+8.0	−0.1
Total	**64,680**	**69,240**	**73,485**	**+4,560**	**+4,245**	**+8,805**	**+7.1**	**+6.1**	**+13.6**
PETROLEUM PRODUCT DEMAND									
OECD and developing countries									
(thousand barrels/day)									
Gasolines	16,551	17,530	18,140	+979	+610	+1,589	+5.9	+3.5	+9.6
Middle distillates	18,465	20,655	22,120	+2,190	+1,465	+3,655	+11.9	+7.1	+19.8
Fuel oil	8,308	8,975	9,440	+667	+465	+1,132	+8.0	+5.2	+13.6
Others	8,079	9,190	9,950	+1,111	+760	+1,871	+13.8	+8.3	+23.2
Total	**51,403**	**56,350**	**59,650**	**+4,947**	**+3,300**	**+8,247**	**+9.6**	**+5.9**	**+16.0**
CRUDE OIL PRICE									
Average world export price ($/barrel)	21.35	18.50	25.00	−2.85	+6.50	+3.65	−13.3	+35.1	+17.1

6. Demand for distillate and special petroleum products will lead the way in the growth of product demand. But lower prices also will stimulate demand for gasoline and heavy fuel oil. Demand for heavy fuel oil could move up even more if environmental concerns slow growth of nuclear energy or coal consumption.

WORLDWIDE OUTLOOK—SUPPLY

The worldwide crude oil supply situation has changed markedly since the conflict in the Persian Gulf. After an extended period of uncertainty which drove up the price of crude oil, the market has experienced an extended period of price stability. The war and subsequent outcome resulted in a substantial volume of crude oil, capacity being removed from the market. The removal of this capacity has contributed greatly

to the extended period of price stability.

The destruction of the producing oil wells in Kuwait eliminated Kuwait's production capacity. And as a result of the Iraqi actions, the U.N. embargo on exports from Iraq was continued. Prior to the invasion these two countries had estimated production capacity of around 5.7 million bbl/d and were producing 4.7 million bbl/d. The two countries were exporting 4.2 million bbl/d. At the present time Iraq has a small volume of production for internal consumption. And Kuwait has managed to put out enough well fires to start up a small volume of production. However these countries are not currently a factor in worldwide crude supply.

For a substantial number of years there has been excess production capacity in the world which has had a tendency to put downward pressure on prices. Most of that excess capacity was in the OPEC countries. With the loss of the production capacity of Kuwait and Iraq a substantial portion of the excess capacity has evaporated. There is even some danger of temporary supply shortages when demand moves up in the winter heating season.

Increased output from some of the major OPEC producing countries, particularly Saudi Arabia, has helped to keep the market from a crisis short supply situation. However, during the period of peak seasonal demand, the world is operating with very little spare capacity. Careful crude stock management has been necessary to keep the market in balance.

Prior to this upheaval, control over the supply side of the world petroleum market was slipping more and more into the hands of OPEC. Total non-OPEC production appears close to peaking. And even if there is potential for some growth in non-OPEC production, it does not appear that it will keep pace with the growth in demand. Therefore OPEC would increase market share along with an increase in overall demand for crude oil.

The recent events in the Middle East did not substantially alter this pattern. The other OPEC countries expanded their production and capacity to make up for the temporary loss. With the capacity increase OPEC is in an even better position to stimulate demand for oil and meet expanded demand requirements.

For the foreseeable future the level of production emanating from the OPEC group of countries will be a major factor in determining the level of crude oil prices, the level of investment, and the level and type of activity throughout the worldwide oil industry.

The OPEC countries should have learned a profitable lesson in 1986 and 1988 when excess production drove prices down to an unacceptably low level. Following the price crash and loss of revenue, OPEC should know that some level of cooperation and restraint is essential to optimize income from the market.

But individual country internal political or economic considerations often outweigh the need to cooperate within OPEC. This dispute between Iraq and Kuwait emphasizes that point. Political considerations often far outweigh economic considerations, and these political moves are hard to predict.

What has not changed because of the upheaval in the Middle East is the fact that there exists substantial oil reserves and oil production capacity in many of the OPEC countries.

For the countries with large reserves, production volumes sufficient to create relatively low oil prices are in their long run best interests. These countries prefer a price that will stimulate long-term steady growth in oil demand.

WORLDWIDE OIL RESERVES

	1979	1980	1981	1982	1983	1984	Jan. 1 1985	1986	1987	1988	1989	1990	1991	Change 1991-1981	% change 1991/1981
							(1,000 bbl)								
Australia	2,100,000	2,130,000	2,360,000	1,709,000	1,622,077	1,586,000	1,430,900	1,449,000	1,712,800	1,691,960	1,673,089	1,676,500	1,566,163	−793,837	−33.6
Brunei	1,480,000	1,800,000	1,710,000	1,630,000	1,240,000	1,390,000	1,400,000	1,480,000	1,420,900	1,420,000	1,400,000	1,375,000	1,350,000	−360,000	−21.1
China	20,000,000	20,000,000	20,500,000	19,895,000	19,485,000	19,100,000	19,100,000	18,420,000	18,400,000	18,400,000	23,550,000	24,000,000	24,000,000	+3,500,000	+17.1
India	2,900,000	2,800,000	2,580,000	2,672,000	3,416,400	3,485,000	3,500,000	3,736,000	4,202,800	4,250,000	6,354,200	7,516,400	7,997,100	+5,417,100	+210.0
Indonesia	10,200,000	9,600,000	9,500,000	9,800,000	9,550,000	9,100,000	8,650,000	8,500,000	8,300,000	8,400,000	8,250,000	8,200,000	11,050,000	−1,550,000	+16.3
Malaysia	2,800,000	2,800,000	3,000,000	2,800,000	3,325,000	3,000,000	3,000,000	3,100,000	2,820,500	2,900,000	2,922,000	2,950,000	2,900,000	−100,000	−3.3
Others	527,200	425,200	480,500	539,800	602,600	408,400	549,000	591,300	566,500	691,690	768,088	827,451	1,378,794	+898,294	+186.9
Total Asia-Pacific	**40,007,200**	**39,355,200**	**40,130,500**	**39,045,800**	**39,241,077**	**38,069,400**	**37,629,900**	**37,276,300**	**37,423,500**	**37,753,650**	**44,917,377**	**46,545,351**	**50,242,057**	**+10,111,557**	**+25.2**
Norway	5,900,000	5,750,000	5,500,000	7,620,000	6,800,000	7,660,000	8,300,000	10,900,000	10,500,000	14,800,000	10,435,000	11,546,204	7,609,412	+2,109,412	+38.4
United Kingdom	16,000,000	15,400,000	14,800,000	14,800,000	13,900,000	13,150,000	13,590,000	13,000,000	9,000,000	5,200,000	5,175,000	4,255,620	3,825,000	−10,975,000	−74.2
Others	2,066,000	2,626,400	2,785,000	2,214,500	2,223,680	2,209,480	2,535,500	2,512,600	2,438,050	2,447,820	2,946,575	3,020,273	3,041,347	+256,347	+9.2
Total Western Europe	**23,966,000**	**23,776,400**	**23,085,000**	**24,634,500**	**22,923,680**	**23,019,480**	**24,425,500**	**26,412,600**	**21,938,050**	**22,447,820**	**18,556,575**	**18,822,087**	**14,475,759**	**−8,609,241**	**−37.3**
U.S.S.R.	71,000,000	67,000,000	63,000,000	63,000,000	63,000,000	63,000,000	63,000,000	61,000,000	59,000,000	59,000,000	58,500,000	58,400,000	57,000,000	−6,000,000	−9.5
Others	3,000,000	3,000,000	2,800,000	2,950,000	2,630,000	2,500,000	2,000,000	1,950,000	1,850,000	1,800,000	1,750,000	1,700,000	1,855,000	−945,000	−33.8
Total E. Europe & U.S.S.R.	**74,000,000**	**70,000,000**	**65,800,000**	**65,950,000**	**65,630,000**	**65,500,000**	**65,000,000**	**62,950,000**	**60,850,000**	**60,800,000**	**60,250,000**	**60,100,000**	**58,855,000**	**−6,945,000**	**−10.6**
Abu Dhabi	30,000,000	28,000,000	29,000,000	30,600,000	30,510,000	30,400,000	30,500,000	31,000,000	31,000,000	92,205,000	92,205,000	92,205,000	92,200,000	+63,200,000	+217.9
Divided Zone	6,480,000	6,260,000	6,060,000	6,500,000	5,840,000	5,695,000	5,420,000	5,380,000	5,212,100	5,210,000	5,210,000	5,200,000	5,000,000	−1,060,000	−17.5
Dubai	1,300,000	1,400,000	1,400,000	1,270,000	1,440,000	1,440,000	1,440,000	1,400,000	1,350,000	4,000,000	4,000,000	4,000,000	4,000,000	+2,600,000	+185.7
Iran	59,000,000	58,000,000	57,500,000	57,000,000	55,308,000	51,000,000	48,500,000	47,876,000	48,800,000	92,850,000	92,850,000	92,860,000	92,850,000	+35,350,000	+61.5
Iraq	32,100,000	31,000,000	30,000,000	29,700,000	41,000,000	43,000,000	44,500,000	44,110,000	47,100,000	100,000,000	100,000,000	100,000,000	100,000,000	+70,000,000	+233.3
Kuwait	66,200,000	65,400,000	64,900,000	64,480,000	64,230,000	63,900,000	90,000,000	89,774,000	91,916,000	91,920,000	91,920,000	94,525,000	94,525,000	+29,625,000	+45.6
Oman	2,500,000	2,400,000	2,340,000	2,570,000	2,730,000	2,790,000	3,500,000	4,000,000	4,032,000	4,012,000	4,071,160	4,250,000	4,300,000	+1,960,000	+83.8
Qatar	4,000,000	3,760,000	3,585,000	3,434,000	3,425,000	3,330,000	3,350,000	3,300,000	3,154,000	3,150,000	3,150,000	4,500,000	4,500,000	+915,000	+25.5
Saudi Arabia	165,700,000	163,350,000	165,000,000	164,600,000	162,400,000	166,000,000	169,000,000	168,800,000	166,573,900	166,980,000	169,970,000	254,959,000	257,504,000	+92,504,000	+56.1
Syria	2,080,000	2,000,000	1,940,000	1,890,000	1,521,000	1,490,000	1,450,000	1,440,000	1,400,000	1,750,000	1,730,000	1,730,000	1,700,000	−240,000	−12.4
Others	636,000	377,300	346,000	795,950	881,893	1,055,800	720,750	945,710	1,340,700	2,603,250	6,412,619	6,018,191	6,018,860	+5,672,860	+1,639.6
Total Middle East	**360,996,000**	**351,947,300**	**362,071,000**	**362,839,950**	**360,295,893**	**370,100,800**	**398,380,750**	**398,825,710**	**401,878,700**	**584,680,250**	**571,518,779**	**600,247,191**	**602,587,860**	**+300,526,860**	**+83.0**
Algeria	6,300,000	8,440,000	8,200,000	8,080,000	9,440,000	9,220,000	9,000,000	8,820,000	8,800,000	8,500,000	8,400,000	9,200,000	9,200,000	+1,000,000	+12.2
Angola-Cabinda	1,115,000	1,200,000	1,200,000	1,450,000	1,635,000	1,700,000	1,800,000	2,000,000	1,149,400	1,149,000	2,024,000	2,024,000	2,074,000	+874,000	+72.8
Congo Republic	315,000	400,000	660,000	1,300,000	1,550,000	430,000	480,000	650,000	720,000	720,000	710,000	830,000	830,000	+170,000	+25.8
Egypt	3,200,000	3,100,000	2,900,000	2,930,000	3,325,000	3,450,000	3,200,000	3,850,000	3,600,000	4,300,000	4,300,000	4,500,000	4,500,000	+1,600,000	+55.2
Libya	24,300,000	23,500,000	23,000,000	22,600,000	21,500,000	21,270,000	21,100,000	21,300,000	21,300,000	21,000,000	22,000,000	22,800,000	22,800,000	−200,000	−0.9
Nigeria	18,200,000	17,400,000	16,700,000	16,500,000	16,750,000	16,550,000	16,650,000	16,600,000	16,000,000	15,980,000	16,000,000	16,000,000	17,100,000	+400,000	+2.4
Tunisia	2,300,000	2,250,000	1,652,000	1,690,000	1,860,000	1,820,000	1,514,000	1,800,000	1,800,000	1,800,000	1,790,000	1,750,000	1,700,000	+48,000	+2.9
Others	2,162,125	782,100	836,375	1,621,630	1,761,690	2,497,020	1,796,550	1,714,050	1,824,650	1,800,700	1,739,770	1,732,620	1,688,140	+851,765	+101.8
Total Africa	**57,892,125**	**57,072,100**	**55,148,375**	**56,171,630**	**57,821,690**	**56,907,020**	**55,540,550**	**56,734,050**	**55,194,050**	**55,249,700**	**56,963,770**	**58,836,620**	**59,892,140**	**+4,743,765**	**+8.6**
Argentina	2,400,000	2,400,000	2,457,000	2,650,000	2,590,000	2,428,700	2,266,000	2,300,000	2,270,000	2,270,000	2,268,000	2,279,900	2,280,000	−177,000	−7.2
Brazil	1,200,000	1,220,000	1,300,000	1,325,060	1,750,000	1,800,000	1,976,000	2,070,000	2,250,000	2,340,000	2,550,000	2,816,000	2,840,000	+1,540,000	+118.5
Canada	6,000,000	6,800,000	6,400,000	7,300,000	7,020,000	6,730,000	7,075,000	6,500,000	6,850,000	6,825,000	6,785,514	6,133,495	5,782,949	−617,051	−9.6
Ecuador	1,170,000	1,100,000	1,100,000	850,000	1,400,000	1,675,000	1,400,000	1,650,000	1,672,300	1,615,000	1,350,000	1,514,000	1,420,000	+320,000	+29.1
Mexico	16,000,000	31,250,000	44,000,000	56,990,000	48,300,000	48,000,000	48,600,000	49,300,000	54,653,000	48,610,000	54,110,000	56,365,000	51,983,000	+7,983,000	+18.1
United States	28,500,000	26,500,000	26,400,000	29,785,000	29,785,000	27,300,000	27,300,000	28,000,000	24,560,000	25,270,000	26,500,000	25,860,000	26,177,000	−223,000	−0.8
Venezuela	18,000,000	17,870,000	17,950,000	20,300,000	21,500,000	24,850,000	25,845,000	25,591,000	25,000,000	56,300,000	58,083,900	58,504,000	59,040,000	+41,090,000	+228.9
Others	2,476,500	2,632,500	2,682,837	2,867,210	2,942,066	2,922,200	3,228,700	3,331,400	2,910,000	3,186,980	3,588,836	3,547,969	3,527,707	+844,870	+31.5
Total Western Hemisphere	**75,746,500**	**80,772,500**	**102,289,837**	**122,067,270**	**115,287,066**	**115,705,900**	**117,690,700**	**118,742,400**	**120,165,300**	**146,416,980**	**155,236,250**	**157,020,364**	**153,050,656**	**+58,760,819**	**+49.6**
Total World	**641,087,825**	**641,923,500**	**648,524,712**	**670,709,150**	**670,189,406**	**680,302,600**	**698,667,400**	**700,141,060**	**697,449,600**	**807,348,400**	**907,442,751**	**1,001,571,623**	**999,113,472**	**+350,588,760**	**+54.1**
Total OPEC	**445,196,000**	**435,831,300**	**434,588,000**	**436,709,000**	**436,858,000**	**449,420,800**	**476,415,000**	**475,211,000**	**477,523,300**	**670,655,800**	**676,068,900**	**767,100,900**	**773,819,000**	**+339,230,900**	**+78.1**
OPEC as % of world	69.4%	67.9%	67.0%	65.1%	65.2%	67.0%	68.2%	67.9%	68.5%	75.6%	74.5%	76.6%	77.5%	—	—

Source: Oil & Gas Journal

WORLDWIDE OIL PRODUCTION*

Country/Area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/80
						(1,000 b/d)						
North America												
U.S.	10,170	10,180	10,200	10,245	10,505	10,545	10,230	9,945	9,765	9,160	8,850	−13.0
Canada	1,765	1,610	1,590	1,660	1,775	1,810	1,800	1,910	2,000	1,940	1,960	11.0
TOTAL NORTH AMERICA	**11,935**	**11,790**	**11,790**	**11,905**	**12,280**	**12,355**	**12,030**	**11,855**	**11,765**	**11,100**	**10,810**	**−9.4**
Latin America												
Argentina	490	490	490	475	465	460	430	430	450	440	450	−8.2
Brazil	195	220	275	365	460	585	595	620	645	640	680	248.7
Colombia	125	135	145	155	170	175	300	385	380	395	430	244.0
Ecuador	205	210	200	240	255	275	280	180	305	295	280	36.6
Mexico	2,155	2,585	3,005	2,950	3,015	3,015	2,750	2,875	2,855	2,895	2,970	37.8
Trinidad	210	200	175	165	170	175	165	165	150	150	150	−28.6
Venezuela	2,235	2,180	1,965	1,875	1,875	1,730	1,845	1,775	1,860	2,010	2,365	5.8
Others	280	280	305	270	285	285	270	250	225	215	215	−23.2
TOTAL LATIN AMERICA	**5,895**	**6,300**	**6,560**	**6,495**	**6,695**	**6,700**	**6,635**	**6,680**	**6,870**	**7,040**	**7,540**	**27.9**
Western Europe												
Austria	30	25	25	25	25	25	20	20	25	25	25	−16.7
Denmark	5	15	35	45	45	60	75	95	95	110	120	2,300.0
France	30	35	50	50	60	70	75	75	75	75	70	133.3
Germany	90	90	85	80	80	80	80	75	80	80	75	−16.7
Italy	35	25	30	40	40	45	50	70	85	80	85	142.9
Norway	525	505	530	660	755	835	910	1,005	1,160	1,530	1,670	218.1
Turkey	45	45	45	45	40	40	45	50	50	55	75	66.7
United Kingdom	1,650	1,835	2,125	2,360	2,580	2,655	2,665	2,555	2,370	1,905	1,895	14.8
Others	65	60	95	145	140	150	155	150	135	115	115	76.9
TOTAL WESTERN EUROPE	**2,475**	**2,635**	**3,020**	**3,450**	**3,765**	**3,960**	**4,075**	**4,095**	**4,075**	**3,975**	**4,130**	**66.9**
U.S.S.R. and Central Europe												
U.S.S.R.	12,215	12,370	12,430	12,520	12,450	12,150	12,560	12,775	12,795	12,460	11,705	−4.2
Central Europe	470	440	495	475	470	445	450	430	425	410	370	−21.3
TOTAL USSR & C. EUROPE	**12,685**	**12,810**	**12,925**	**12,995**	**12,920**	**12,595**	**13,010**	**13,205**	**13,220**	**12,870**	**12,075**	**−4.8**
Middle East												
Abu Dhabi	1,345	1,135	885	830	825	890	1,090	1,200	1,280	1,565	1,850	37.5
Dubai & N. Emirates	360	370	365	350	395	460	465	495	495	470	450	25.0
Iran	1,480	1,325	2,410	2,465	2,195	2,215	1,905	2,310	2,265	2,845	3,125	111.1
Iraq	2,645	895	1,010	1,105	1,225	1,440	1,745	2,090	2,600	2,825	2,005	−24.2
Kuwait	1,430	965	705	900	985	920	1,250	1,075	1,340	1,640	1,065	−25.5
Neutral Zone	545	375	315	310	405	340	345	390	320	370	275	−49.5
Oman	285	325	325	390	420	505	560	580	595	590	660	131.6
Qatar	460	425	340	310	425	340	355	340	360	410	455	−1.1
Saudi Arabia	9,990	9,985	6,695	5,225	4,760	3,565	5,150	4,360	5,255	5,280	6,700	−32.9
Others	215	215	220	225	220	220	240	285	495	570	630	193.0
TOTAL MIDDLE EAST	**18,755**	**16,015**	**13,270**	**12,110**	**11,855**	**10,895**	**13,105**	**13,125**	**15,005**	**16,565**	**17,215**	**−8.2**
Africa												
Algeria	1,120	1,035	1,045	980	1,075	1,095	1,125	1,135	1,090	1,205	1,275	13.8
Angola	150	140	120	160	185	230	260	350	450	455	470	213.3
Egypt	590	690	705	725	860	905	835	915	880	890	915	55.1
Gabon	175	150	155	155	150	155	160	155	175	215	250	42.9
Libya	1,830	1,220	1,135	1,110	1,105	1,105	1,045	1,000	1,055	1,160	1,350	−26.2
Nigeria	2,055	1,440	1,285	1,235	1,385	1,475	1,465	1,290	1,365	1,635	1,810	−11.9
Others	260	305	340	380	440	450	465	445	465	465	465	78.8
TOTAL AFRICA	**6,180**	**4,980**	**4,785**	**4,745**	**5,200**	**5,415**	**5,375**	**5,290**	**5,480**	**6,025**	**6,535**	**5.7**
Asia and Australasia												
Brunei	235	175	165	175	160	150	165	140	145	145	145	−38.3
China	2,125	2,035	2,050	2,135	2,300	2,515	2,630	2,675	2,750	2,790	2,800	31.8
India	190	300	400	510	565	605	625	615	645	690	685	260.5
Indonesia	1,575	1,680	1,415	1,345	1,410	1,335	1,400	1,320	1,325	1,415	1,520	−3.5
Japan	10	10	10	10	10	10	15	10	10	10	15	50.0
Malaysia	275	250	295	420	440	435	540	505	545	585	625	127.3
Other Asia	60	50	55	70	85	100	115	110	105	110	120	100.0
Australasia	400	410	420	470	550	635	610	620	600	575	660	65.0
TOTAL ASIA & AUSTRALASIA	**4,870**	**4,910**	**4,810**	**5,135**	**5,520**	**5,785**	**6,100**	**5,995**	**6,125**	**6,320**	**6,570**	**34.9**
TOTAL WORLD	**62,795**	**59,440**	**57,160**	**56,835**	**58,235**	**57,705**	**60,330**	**60,245**	**62,540**	**63,895**	**64,875**	**3.3**
OPEC	**27,450**	**23,390**	**19,925**	**18,435**	**18,470**	**17,340**	**19,625**	**19,115**	**21,890**	**23,340**	**24,775**	**−9.7**

*Includes natural gas liquids.
Source: British Petroleum

REVIEW

PRODUCTION. Economic activity worldwide expanded substantially and with little interruption throughout the 1950s, the 1960s and into the 1970s. A substantial proportion of the economic activity and growth was fueled by crude oil. Worldwide production of crude oil expanded steadily throughout this period to meet the ever-increasing demand. New field development and capacity additions were sustained at a pace close to that of the demand for oil, which in turn tracked the economic growth rate.

Two major price increases, the first in 1973–1974 and the second in 1979–1981, put an end to this steady climb in crude production. With worldwide economic growth fueled by oil consumption, the first price increase only slowed consumption. But it did give rise to some serious thought about investment in energy conservation.

The second price increase was much larger and managed to stop the growth in oil consumption and production in its tracks. The second major price increase occurred in the 1979–1981 period. It was the major reason for the subsequent decrease in consumption and production of oil. Not only were steps taken to conserve energy and to reduce energy costs, but these adjustments led to a slowdown in economic activity. And this contributed further to the drop in demand for oil.

Total world hydrocarbon liquids production (crude oil, condensate, and natural gas liquids) peaked in 1979 at 65.78 million bbl/d. Production in the non-communist world also peaked in 1979 at 51.28 million bbl/d. The increased cost of oil forced conservation, and world production fell for four consecutive years, 1979–1983, dropping to 56.69 million bbl/d in 1983. This was a drop in production of 9.09 million bbl/d, or 13.8%.

Non-communist production, which is more sensitive to market forces, fell 9.74 million bbl/d (19%) to 41.54 million bbl/d. Communist area production actually continued to rise over this period, increasing from 14.495 million bbl/d in 1979 to 15.145 million bbl/d in 1983.

The drop in world crude production mirrored the drop in demand for petroleum products. The latter was a direct result of the sharp increase in the price of oil products, resulting from the OPEC crude price increases. In addition, there was a rapid shift to other energy sources for fueling economic growth. Although the costs of other energy forms were also on the rise, they were not increasing as rapidly as the cost of oil. Oil led the way and became the highest-cost energy form for many economic activities.

With declining demand for crude oil products and therefore for crude production, prices began to slide in the last half of 1981. With weak demand relative to supply, prices slid downward gradually throughout the 1981–1985 period.

The downward pressure on prices from the excess capacity and the excess production intensified in 1986 and prices plummeted sharply. Tighter supply due to some OPEC production discipline led to a slight rebound in 1987. Excess OPEC production put downward pressure on prices again in 1988. Prices weakened and fell although they did not fall as sharply or as far as in 1986. The following year, 1989, was a repeat of 1987 with a rebound in prices followed by relative price stability. A sharp drop in U.S. and U.K. production coupled with some OPEC production discipline helped to stabilize the market. Prices were weak in 1990 but did not drop sharply as in 1986 and 1988. Prices were beginning to move up just prior to the invasion. Following the invasion, prices moved up to some of the

highest levels since the first half of the 1980s. Average prices in 1990 were up about 25% from 1989 primarily because of the risk premium resulting from the Iraq and Kuwait upheaval.

The lower prices slowed conservation efforts and slightly stimulated demand during the 1981–1985 period. There was also a slight rebound in production in 1984, both total world and non-communist. Non-communist production increased 1.33 million bbl/d, 3.2%, to 42.87 million bbl/d. Total world output increased 1.41 million bbl/d, up 2.5% to 58.1 million bbl/d. Lower crude oil prices and increased economic growth and increased oil product demand were the major reasons for this increase in production. The year following, in 1985, production slipped slightly. Total non-communist production dropped to 42.58 million bbl/d. Total world output fell to 57.71 million bbl/d.

However, this was reversed again when the slump in prices in 1986 kicked off a surge in demand for oil. Non-communist output jumped up 2.2 million bbl/d to 44.7 million bbl/d, total world output was up 2.7 million bbl/d at 60.4 million bbl/d, the highest level since 1980.

Due to higher prices, output slipped slightly in 1987, falling 225,000 bbl/d. The drop was all in the non-communist output which dipped 460,000 bbl/d. Lower crude prices in 1988 again reversed the direction, and output moved up over 2 million bbl/d. Non-communist output jumped up to 46.4 million bbl/d, and total world production moved up to 62.35 million bbl/d. Prices were relatively stable throughout most of 1989 but low enough to stimulate demand. Non-communist production moved up another 1.4 million bbl/d on the strength of the strong economic growth and product demand. Communist production dipped due to internal production problems in the USSR.

The conflict in the Persian Gulf and the higher prices did not stifle demand for crude oil in 1990. Worldwide production moved up 1.4% to 64.875 million bbl/d. OPEC output moved up 6.2% to 24.775 million bbl/d. Production from the USSR fell again, declining 6.1% to 11.075 million bbl/d. Production elsewhere in Eastern Europe also fell as political and economic changes continued to cause problems.

These movements in crude production and prices show that the level of output or demand for crude oil is quite obviously very sensitive to the price of crude oil and is being dampened or stimulated by the volatile price movements.

OPEC PRODUCTION AND CAPACITY. The initial drop in prices in 1981–1983 was mainly due to the development of a massive excess crude oil production capacity worldwide. The vast majority of the excess capacity developed in the OPEC countries. Both the increased output in non-OPEC countries and the drop in product demand worldwide contributed to the development of an excess capacity problem in the oil industry. In fact, the worldwide production capacity situation is the real key to understanding the world oil supply situation and crude oil price developments.

Throughout the 1950s, 1960s and into the 1970s, as more and more oil was required to fuel worldwide economic growth, production capacity was expanded to meet the demand. Production facilities were installed to allow a buffer for maintenance and other non-routine contingencies. Generally, development plans called for output to average about 92% of installed capacity. This allows for some excess capacity for maintenance downtime and other contingencies.

The international oil companies, as a

WORLDWIDE NATURAL GAS PRODUCTION

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/80
	(Billion cu ft)											
North America												
U.S.	19,510	19,306	17,891	16,201	17,573	16,570	16,143	16,707	17,126	17,236	17,397	−10.8
Canada	2,709	2,642	2,607	2,454	2,524	2,701	2,521	2,771	3,203	3,410	3,450	27.4
TOTAL NORTH AMERICA	**22,219**	**21,948**	**20,498**	**18,655**	**20,097**	**19,271**	**18,664**	**19,478**	**20,329**	**20,646**	**20,847**	**−6.2**
Latin America												
Argentina	278	294	341	365	474	498	662	659	757	855	855	207.6
Bolivia	86	90	94	90	86	86	90	94	98	102	106	23.3
Colombia	98	102	98	133	149	145	145	145	172	169	141	43.9
Mexico	851	913	1,007	1,000	976	992	874	929	921	933	953	12.0
Trinidad	86	86	86	106	122	114	125	137	157	153	145	68.6
Venezuela	588	588	600	553	612	612	674	655	662	659	764	29.9
Others	125	118	149	172	200	223	227	231	235	220	227	81.6
TOTAL LATIN AMERICA	**2,112**	**2,191**	**2,375**	**2,419**	**2,619**	**2,670**	**2,797**	**2,850**	**3,002**	**3,091**	**3,191**	**51.1**
Western Europe												
France	274	259	243	216	208	176	137	125	102	102	98	−64.2
Germany	553	564	494	514	537	478	537	592	553	533	525	−5.1
Italy	404	455	498	435	459	486	564	576	584	600	612	51.5
Netherlands	2,701	2,650	2,285	2,395	2,411	2,524	2,203	2,199	1,956	2,121	2,136	−20.9
Norway	925	921	898	898	972	894	953	1,047	1,051	1,086	980	5.9
United Kingdom	1,254	1,250	1,196	1,200	1,305	1,454	1,529	1,599	1,541	1,501	1,603	27.8
Others	90	86	106	110	129	161	180	176	196	227	227	152.2
TOTAL WESTERN EUROPE	**6,201**	**6,185**	**5,720**	**5,768**	**6,021**	**6,173**	**6,103**	**6,314**	**5,983**	**6,170**	**6,181**	**−0.3**
U.S.S.R. and Central Europe												
U.S.S.R.	14,104	15,276	16,241	17,377	19,032	20,843	21,725	22,983	24,292	25,112	25,711	82.3
Central Europe	1,517	1,592	1,599	1,650	1,752	1,760	1,791	1,740	1,576	1,505	1,505	−0.8
TOTAL U.S.S.R. AND CENTRAL EUROPE	**15,621**	**16,868**	**17,840**	**19,027**	**20,784**	**22,603**	**23,516**	**24,723**	**25,868**	**26,617**	**27,216**	**74.2**
Middle East												
Abu Dhabi	192	255	235	239	329	431	506	561	576	655	717	273.4
Iran	294	255	255	388	478	514	537	564	706	764	843	186.7
Kuwait	243	188	145	169	153	149	204	169	227	286	192	−21.0
Saudi Arabia	341	576	439	427	643	662	902	945	1,027	1,051	1,078	216.1
Others	388	329	365	325	416	470	506	651	800	851	819	111.1
TOTAL MIDDLE EAST	**1,458**	**1,603**	**1,439**	**1,548**	**2,019**	**2,226**	**2,655**	**2,890**	**3,336**	**3,607**	**3,649**	**150.3**
AFRICA												
Algeria	757	866	941	1,258	1,192	1,211	1,219	1,396	1,470	1,576	1,666	120.1
Egypt	0	0	4	4	4	8	8	8	8	12	12	—
Libya	184	141	118	129	161	184	223	235	200	212	235	27.7
Nigeria	39	63	43	51	59	51	43	129	133	153	149	282.1
Others	67	71	106	122	161	216	227	247	267	294	314	368.7
TOTAL AFRICA	**1,047**	**1,141**	**1,212**	**1,564**	**1,577**	**1,670**	**1,720**	**2,015**	**2,078**	**2,247**	**2,376**	**126.9**
Asia and Australasia												
China	478	455	392	423	427	451	463	490	494	506	517	8.2
Japan	78	74	71	74	74	78	74	78	74	74	59	−24.4
Indonesia	655	678	694	780	1,027	1,070	1,247	1,290	1,341	1,564	1,595	143.5
Malaysia	0	0	0	8	267	361	494	549	580	659	678	—
Other East Asia	318	329	372	439	416	478	455	506	561	561	561	76.4
Pakistan	243	239	310	337	357	365	388	419	443	439	451	85.6
Other South Asia	220	259	361	404	494	506	529	600	678	745	843	283.2
Australasia*	427	466	494	533	545	600	682	678	706	788	890	108.4
TOTAL ASIA AND AUSTRALASIA	**2,419**	**2,500**	**2,694**	**2,998**	**3,607**	**3,909**	**4,332**	**4,610**	**4,877**	**5,336**	**5,594**	**131.3**
TOTAL WORLD	**51,077**	**52,436**	**51,778**	**51,979**	**56,724**	**58,522**	**59,787**	**62,880**	**65,473**	**67,714**	**69,054**	**35.2**

*Includes Australia and New Zealand.

Source: British Petroleum

rule, obtained concessions and developed the lower cost areas first. These were mainly the prolific fields of the OPEC countries. Capacity seldom exceeded demand by a large amount because the rate of installation of new capacity was regulated to meet demand growth.

As demand for oil increased throughout the 1960s and into the 1970s, it was

PRICE–ARABIAN LIGHT CRUDE

Year	Average government selling price (U.S. dollars per barrel)	Average spot market price (U.S. dollars per barrel)	Difference (U.S. dollars per barrel)
1975	10.46	10.70	+ 0.24
1976	11.51	11.63	+ 0.12
1977	12.09	12.43	+ 0.34
1978	12.70	13.00	+ 0.30
1979	13.34	29.89	+16.55
1980	26.00	35.69	+ 9.69
1981	32.00	34.30	+ 2.30
1982	34.00	31.76	- 2.24
1983	34.00	28.80	- 5.20
1984	29.00	27.80	- 1.20
1985	29.00	26.60	- 2.40
1986	28.00	23.00	- 5.00
1987	17.53	17.29	- 0.24
1988	13.43	13.28	- 0.15
1989	16.35	16.30	- 0.05
1990	21.53	21.46	- 0.07

Source: Energy Information Administration

WORLD CRUDE OIL PRICES

Official Sales and Term Contracts
(Dollars per barrel)
(1 January)

Year	Total World	Total OPEC	Total Non-OPEC	Difference Non-OPEC-OPEC
1979	13.08	13.03	13.44	+0.41
1980	28.84	28.30	31.94	+3.64
1981	35.49	34.82	38.54	+3.72
1982	34.18	34.13	34.35	+0.22
1983	33.00	33.54	31.72	-1.82
1984	28.61	28.59	28.65	+0.06
1985	28.33	28.43	28.16	-0.27
1986	27.10	27.81	26.14	-1.67
1987	16.24	16.10	16.44	+0.34
1988	16.57	16.77	16.21	-0.56
1989	13.58	13.36	14.06	+0.70
1990	18.91	18.72	19.29	+0.57
1991	24.72	24.18	25.78	+1.60
CHANGE 1981 to 1991				
Actual	-10.77	-10.64	-12.76	
Percentage	-30.3 %	-30.6 %	-33.1 %	
CHANGE 1979 to 1981				
Actual	+ 22.41	+ 21.79	+ 25.10	
Percentage	+171.3 %	+167.2 %	+186.8 %	

Source: Energy Information Administration

increased production from the OPEC countries that filled the need. By 1976, OPEC output represented 51.8% of total worldwide output and 65.6% of non-communist world production.

OPEC production actually peaked in 1977 at 31.68 million bbl/d, 50.6% of worldwide production and 64.5% of non-communist production. OPEC output remained above 30 million bbl/d in 1978 and 1979, with 1979 at 31.47 million bbl/d. That was 47.8% of total world demand and 61.4% of non-communist demand for that year.

By 1979 OPEC was beginning to lose a part of its market share because the substantial increase in prices stimulated the development of crude production in non-OPEC countries, and non-OPEC output was beginning to supply a greater proportion of demand.

In the late 1960s and early 1970s, as worldwide demand was on the rise, the OPEC countries gained control of their own oil resources by taking control from the international oil companies. And they subsequently changed the approach to supplying worldwide oil demand that had been followed by the international oil companies.

The international companies had been efficient at exploration and production. The price was kept low by continuous development of additional oil resources in the face of rising demand. Oil resources were abundant in many of the OPEC countries, and the international oil companies managed to increase capacity to keep step with demand. This also kept prices low, and the low prices encouraged increased consumption.

The OPEC countries had contended for some time that their oil resources were worth more than the revenues received. When OPEC took control they changed course and raised prices. They took advantage of the worldwide dependence on oil and the worldwide economic expansion that was being fueled by oil. They chose to test the demand response to higher prices (elasticity of demand) and raised prices sharply in 1973–1974. Even in the face of a sharp price hike demand continued to rise. So they boosted prices again in 1979–1981.

These price hikes had a dramatic impact on the production capacity situation worldwide, but particularly in the OPEC countries.

OECD* PETROLEUM STOCKS

	(Million barrels)								— 1983/1980 —		— 1990/1983 —	
	1980	1983	1985	1986	1987	1988	1989	1990	Change	% change	Change	% change
Canada	164	121	113	111	126	116	114	124	− 43	−26.2	+ 3	+ 2.5
France	243	153	139	127	127	140	138	139	− 90	−37.0	−14	− 9.2
Italy	170	149	157	155	169	155	164	172	− 21	−12.4	+ 23	+15.4
Japan	495	470	494	509	540	538	577	591	− 25	− 5.1	+121	+25.7
United Kingdom	168	118	123	124	121	112	118	113	− 50	−29.8	− 5	− 4.2
United States	1,392	1,454	1,519	1,593	1,607	1,597	1,581	1,621	+ 62	+ 4.5	+167	+11.5
West Germany	319	249	233	252	259	266	271	263	− 70	−21.9	+ 14	+ 5.6
Other OECD	636	541	506	547	525	516	513	540	− 95	−14.9	− 1	− 0.2
Total OECD	**3,587**	**3,255**	**3,284**	**3,418**	**3,474**	**3,440**	**3,476**	**3,563**	**−332**	**− 9.3**	**+308**	**+ 9.5**

*Organization for Economic Cooperation & Development.
Source: Energy Information Administration

THE STRAIT OF HORMUZ—1990

Country	Crude oil production (1,000 b/d)
Iran	3,136
Kuwait	1,079
Bahrain	42
Saudi Arabia	6,302
Qatar	393
United Arab Emirates	2,117
Total	**13,069**
World production	60,477
% of world production	21.6
Exports via Strait of Hormuz	
Crude	8,000
Products	*1,400
Total	**9,400**
World crude imports	23,854
% of world crude imports	33.5
World crude & product imports	31,441
% of world crude & product imports	29.9

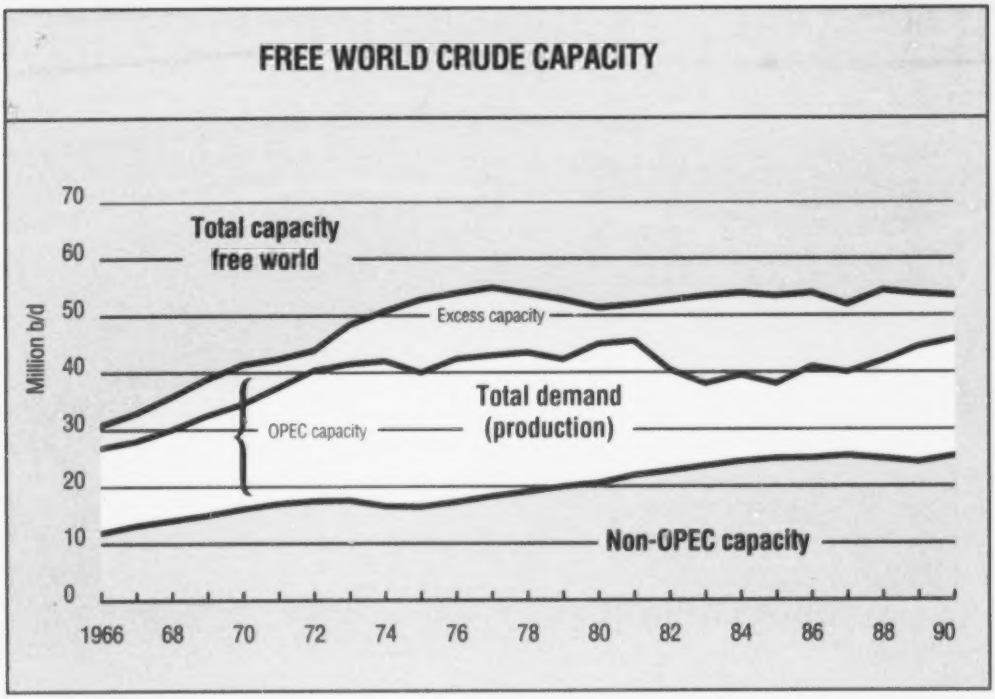
Source: Author's estimates

Through the 1960s and up until 1973, excess capacity in the worldwide oil industry was 7–8%. Excess capacity was about 7% of total capacity and 8% of production. After the initial price hike, excess capacity began to increase, moving up to 10–12% in 1974 and as high as 19–25% in 1975. This was 19% of available capacity and 25% of actual production. The Iranian revolution in 1978–1979 took some Iranian capacity out of service and helped reduce excess capacity to the 9–10% level. This allowed OPEC to push through the massive 1979–1981 price increase.

However, following 1979, the combination of declining demand and rising non-OPEC production resulted in the development of massive excess capacity. Most OPEC capacity had been put in place by 1977, but non-OPEC production was stimulated by the increase in prices, and new capacity was added continuously. Only the Iranian revolution and the Iran-Iraq war kept the excess capacity situation somewhat in check. But by 1983 excess capacity was 15.6 million bbl/d, which was 29% of total capacity and 41% of total production/demand. This started to put substantial downward pressure on prices.

Excess capacity dropped only marginally in 1984 to 15.3 million bbl/d. This was still 28% of total available non-communist capacity and 39% of total production. In 1985, excess capacity moved up again to 15.6 million bbl/d. This represented 29% of total non-communist oil production capacity and about 40% of total oil production. In 1986 the excess capacity fell slightly to 14 million bbl/d. This was 26% of total capacity and 35% of total production. In 1987 there was little change in these numbers. And the excess capacity continued to exert downward pressure on prices.

These capacity numbers exclude some capacity in Iran and Iraq that was damaged or was shut in due to the war. Iran's production prior to the war was close to 6 million bbl/d. But its present capacity is estimated at only around 3.0 million bbl/d. Iraq has been rapidly developing reserves, but production capacity



was also limited due to the war.

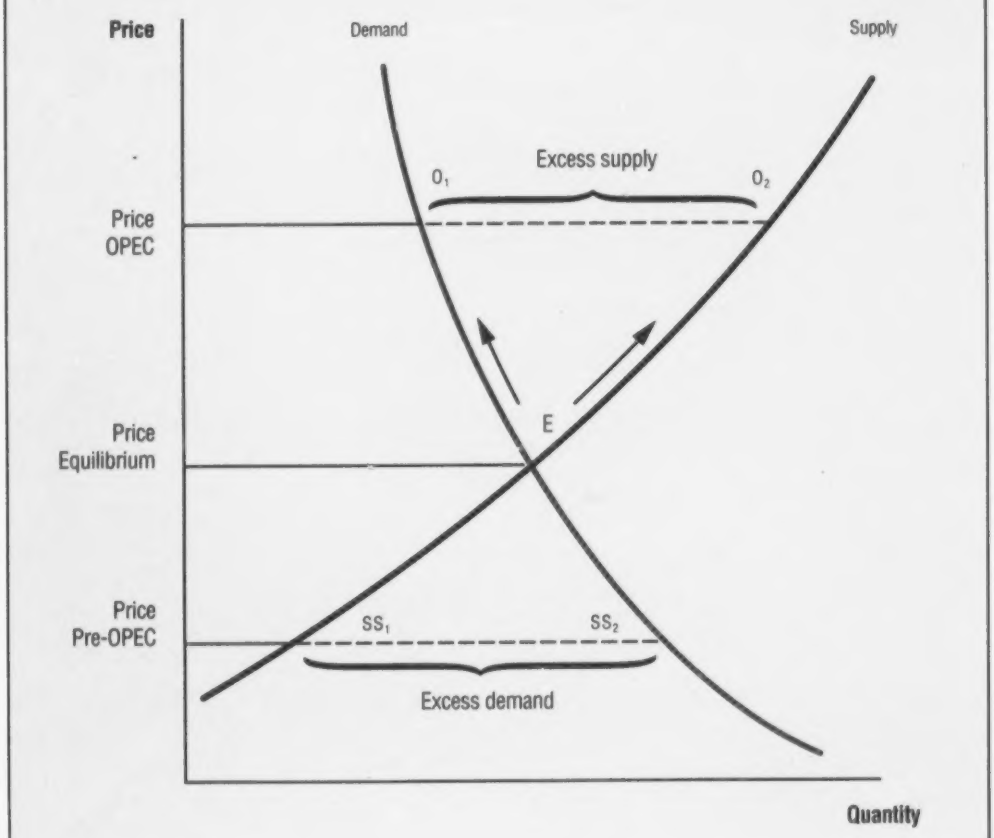
Following the cease fire these two countries began to work on increasing their capacity. Iranian capacity moved up 400,000 bbl/d to 3.4 million bbl/d. Iraqi capacity is now estimated at 3.5 million bbl/d. It was expected that there would be additional capacity added to OPEC in these two countries now that the hostilities have ceased. In fact, one of the key determinants of the level of prices over the next few years was expected to be the production levels adopted by Iran and Iraq. If they added considerably to present production levels, it would put additional downward pressure on prices. The war in the Persian Gulf has altered this.

OPEC adopted a very aggressive pricing policy when demand and capacity were in line. It took advantage of the dependency upon oil to fuel economic growth. But because OPEC led the way in boosting prices, when demand fell it resulted in a drop in demand for OPEC oil. The consuming areas looked to other supplies before turning to OPEC for marginal requirements.

OPEC production peaked in 1977 at 31.7 million bbl/d. This was 64.5% of free world production. By 1982, for the first time in its history, OPEC production fell below 50% of free world production. In that year, OPEC output was 19.93 million bbl/d, 47.4% of free world output.

By 1984 OPEC crude production had fallen to 18.5 million bbl/d, a drop of 41.7%. This was only 43% of total free world production. And in 1985, OPEC production fell another 6.8% to 17.215 million bbl/d. This was 40.5% of non-communist output and 29.9% of total world production. OPEC output had fallen 45.7% from the 1977 peak, a drop of 14.465 million bbl/d. And the drop wasn't because of a drop in available capacity. Over this period

THEORETICAL SUPPLY AND DEMAND FOR WORLD OIL



low demand caused available capacity to be shut in.

This drastic drop in market share irritated members of OPEC and led to OPEC adopting a market share policy in 1986. With sharply lower prices, demand for OPEC oil rebound in 1986, jumping up 13.6% to total liquids output of 19.56 million bbl/d.

Market share increased but this policy also led to lower prices and lower OPEC revenues. In today's competitive market, it's impossible for OPEC to have it both ways—high market share and high price.

In 1987, OPEC gave up a bit of market share and got slightly higher prices. But they had a great deal of difficulty maintaining production discipline, and in 1988 they pushed more oil into the market and forced prices

WORLDWIDE OIL REFINING THROUGHPUTS

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/81
						(1,000 b/cd)					
U.S.	12,470	11,775	11,685	12,045	12,005	12,715	12,855	13,445	13,550	13,595	9.0
Canada	1,780	1,520	1,455	1,460	1,430	1,395	1,460	1,535	1,555	1,595	-10.4
Latin America	6,700	6,205	5,955	5,845	5,585	5,615	5,665	5,590	5,750	5,870	-12.4
Western Europe	11,385	10,525	10,165	10,255	9,950	10,510	10,380	10,725	10,760	11,090	- 2.6
U.S.S.R. and Central Europe	12,210	12,265	12,255	12,005	11,725	11,990	12,030	12,070	11,950	11,120	- 8.9
Middle East	2,205	2,245	2,515	2,665	2,795	2,950	2,970	3,140	3,380	3,290	49.2
Africa	1,525	1,735	1,920	1,975	2,015	2,095	2,170	2,200	2,280	2,335	53.1
China	1,395	1,520	1,600	1,765	1,785	1,865	1,950	2,035	2,110	2,130	52.7
Japan	3,630	3,360	3,255	3,355	3,120	2,990	2,910	2,990	3,175	3,465	- 4.5
South Asia	795	840	880	885	1,020	1,120	1,150	1,160	1,240	1,245	56.6
Other Asia	2,510	2,365	2,410	2,485	2,685	2,800	2,785	2,915	3,115	3,320	32.3
Australasia*	655	625	605	615	580	580	645	680	700	715	9.2
TOTAL WORLD	**57,260**	**54,980**	**54,700**	**56,355**	**54,695**	**56,625**	**56,970**	**58,485**	**59,565**	**59,770**	**4.4**
Of which OECD and LDCs†	43,500	41,040	40,685	41,425	41,015	42,600	42,815	44,205	45,235	46,255	6.3

*Includes Australia and New Zealand.
†Organization for Economic Cooperation and Development; and lesser developed countries

Source: British Petroleum

down again. Discipline returned, at least temporarily, in 1989 and prices moved back up. Prices remained fairly firm in 1990 but did slide as seasonal demand weakened. Prices began to move up when the invasion occurred.

There was a dramatic change in OPEC effective capacity after the Iraq invasion of Kuwait. The loss of output from Iraq and Kuwait removed 5.7 million bbl/d of capacity. This removed a substantial portion of the excess capacity that had been making it difficult for OPEC to maintain production at the quota level and balance the market. Saudi Arabia and several other OPEC producers boosted their capacity to make up for the loss of capacity from Kuwait and Iraq. OPEC capacity fell 4.25 million bbl/d from the level prior to the invasion of Kuwait.

The loss of this capacity could have put a lot of upward pressure on prices following the conflict. The willingness of Saudi Arabia and the other OPEC producers to boost output added sufficient capacity to prevent a shortage and to balance the market. This enabled oil prices to slide following the invasion. However during periods of peak seasonal demand the market is operating at very close to capacity.

NON-OPEC PRODUCTION. The OPEC countries are not the only crude oil producers in the world. In response to the higher prices engineered by OPEC, the production in non-OPEC, non-communist countries increased steadily from 1975 through 1985. This was a classical economic supply response to substantially higher prices.

Non-OPEC, non-communist production increased 55.5% from 16.255 million bbl/d in 1975 to 25.275 million bbl/d in 1985. The OPEC-led increase in crude oil prices made oil production economical in a number of other areas of the world. The increases in non-OPEC production occurred throughout the world. Major increases have been recorded in Brazil, Colombia, and Mexico in the western hemisphere. Norway and the United Kingdom have boosted production substantially in Western Europe. Elsewhere, there have been large increases in Egypt, Angola, Malaysia, and India. And new production has started in Yemen. A number of these countries have become major exporters of crude oil and are in direct competition with the OPEC exporters.

Non-OPEC production fell slightly in 1986, declining 0.6%, 160,000 bbl/d, down to

WORLDWIDE OIL REFINING CAPACITIES

Country/Area	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/81
						(1,000 bc/d)							
North America													
U.S.	17,920	18,250	18,290	16,860	15,865	15,660	15,460	15,460	15,565	15,930	15,695	15,560	−14.9
Canada	2,315	2,150	2,155	2,260	2,025	2,015	2,075	2,080	2,050	1,890	1,850	1,880	−12.8
TOTAL NORTH AMERICA	**20,235**	**20,400**	**20,445**	**19,120**	**17,890**	**17,675**	**17,535**	**17,540**	**17,615**	**17,820**	**17,545**	**17,440**	**−14.7**
Latin America													
Argentina	660	690	690	690	690	680	665	670	690	690	690	695	0.7
Brazil	1,230	1,375	1,530	1,530	1,400	1,305	1,305	1,320	1,405	1,405	1,480	1,490	−2.6
Mexico	1,340	1,475	1,525	1,620	1,630	1,680	1,790	1,790	1,790	1,765	1,930	1,990	30.5
Netherlands Antilles	840	840	780	780	780	740	320	320	320	320	320	320	−59.0
Trinidad	465	455	455	375	375	320	260	300	300	300	300	245	−46.2
Venezuela	1,445	1,425	1,405	1,360	1,225	1,225	1,230	1,225	1,200	1,200	1,200	1,165	−17.1
Others	2,765	2,740	2,680	2,540	2,365	2,140	1,855	1,875	1,870	1,890	2,010	2,050	−23.5
TOTAL LATIN AMERICA	**8,745**	**9,000**	**9,065**	**8,895**	**8,465**	**8,090**	**7,425**	**7,500**	**7,575**	**7,570**	**7,930**	**7,955**	**−12.2**
Western Europe													
Belgium	1,020	1,020	965	720	720	720	720	710	705	705	705	705	−26.9
France	3,420	3,320	3,230	2,745	2,370	2,190	2,175	2,040	1,900	1,810	1,700	1,700	−47.4
Germany	3,040	3,575	3,440	3,055	2,815	2,650	2,285	2,215	2,180	2,170	2,020	2,025	−41.1
Italy	4,205	4,140	3,990	3,500	3,365	2,745	2,585	2,555	2,480	2,345	2,340	2,300	−42.4
Netherlands	1,815	1,775	1,775	1,590	1,610	1,435	1,380	1,380	1,380	1,395	1,395	1,395	−21.4
Spain	1,475	1,425	1,550	1,550	1,440	1,440	1,440	1,420	1,420	1,420	1,420	1,420	−8.4
United Kingdom	2,460	2,460	2,360	2,135	2,105	1,935	1,865	1,835	1,820	1,820	1,825	1,825	−22.7
Others	2,665	2,820	2,830	2,945	2,745	2,705	2,750	2,710	2,830	2,870	2,815	2,820	−0.4
TOTAL WESTERN EUROPE	**20,100**	**20,535**	**20,140**	**18,240**	**17,170**	**15,820**	**15,200**	**14,865**	**14,715**	**14,535**	**14,220**	**14,190**	**−29.5**
U.S.S.R. and Central Europe													
U.S.S.R.	10,500	10,700	11,600	11,750	12,000	12,000	12,000	12,260	12,260	12,260	12,300	12,300	6.0
Central Europe	2,660	2,230	2,440	2,435	2,435	2,435	2,435	2,530	2,560	2,655	2,975	2,975	21.9
TOTAL U.S.S.R. & C. EUROPE	**13,160**	**12,930**	**14,040**	**14,185**	**14,435**	**14,435**	**14,435**	**14,790**	**14,820**	**14,915**	**15,275**	**15,275**	**8.8**
Middle East													
Bahrain	250	250	250	250	250	250	250	250	250	250	255	250	0.0
Iran	1,045	1,225	625	625	600	530	530	530	530	530	530	720	15.2
Iraq	265	265	265	265	200	300	320	320	320	320	320	320	20.8
Kuwait	575	575	530	545	590	590	630	620	630	815	820	820	54.7
Saudi Arabia	635	495	660	865	865	865	1,115	1,125	1,375	1,375	1,485	1,860	181.8
Others	770	755	920	1,015	1,055	980	965	1,005	1,060	1,075	1,075	1,080	17.4
TOTAL MIDDLE EAST	**3,540**	**3,565**	**3,250**	**3,565**	**3,560**	**3,515**	**3,810**	**3,850**	**4,165**	**4,365**	**4,485**	**5,050**	**55.4**
AFRICA	2,000	2,060	2,035	2,355	2,340	2,540	2,555	2,550	2,630	2,810	2,835	2,885	41.8
Asia & Australasia													
China	1,900	1,900	1,810	2,000	2,050	2,150	2,150	2,170	2,230	2,340	2,470	2,470	36.5
Indonesia	535	515	515	515	760	760	780	780	780	780	780	780	51.5
Japan	5,285	5,675	5,675	5,500	4,975	4,975	4,975	4,705	4,565	4,365	4,200	4,385	−22.7
Singapore	1,040	1,020	1,020	1,020	1,020	1,020	1,020	960	860	930	1,015	1,060	3.9
South Asia	825	870	885	995	1,020	995	1,150	1,225	1,295	1,285	1,310	1,355	53.1
Other Asia	1,850	1,930	1,980	1,980	1,980	2,160	2,045	2,145	2,145	2,070	2,125	2,175	9.8
Australasia*	800	810	815	815	815	785	705	740	730	745	755	755	−7.4
TOTAL ASIA & AUSTRALASIA	**12,235**	**12,720**	**12,700**	**12,825**	**12,620**	**12,845**	**12,825**	**12,725**	**12,605**	**12,515**	**12,655**	**12,980**	**2.2**
TOTAL WORLD	**80,015**	**81,210**	**81,675**	**79,185**	**76,480**	**74,920**	**73,785**	**73,820**	**74,125**	**74,530**	**74,945**	**75,775**	**−7.2**
Of which OECD & LDCs†	64,805	66,195	65,620	62,790	59,790	58,130	57,005	56,670	56,875	57,080	56,880	57,715	−12.0

*Includes Australia and New Zealand.
†Organization for Economic Cooperation and Development; and lesser developed countries
Source: British Petroleum

25.09 million bbl/d. Most of the decline was attributable to the drop in U.S. liquids output. That drop was due to the sharp fall in prices. Much of the U.S. production in older, smaller fields is high cost output. Therefore some production was shut in when prices dipped.

With slipping U.S. production, total non-OPEC output fell another 95,000 bbl/d in 1987 to 24.995 million bbl/d. Production rebounded in 1988, increasing to 25.47 million bbl/d. It fell again in 1989 to 24.89 million bbl/d but moved back up to 25.2 million bbl/d in 1990.

In addition to increasing non-OPEC, non-communist production, the USSR was

FREE WORLD ACTIVE RIG COUNT

Region	(Annual average) 1980 Total	1981 Total	1982 Total	1983 Total	1984 Total	1985 Total	1986 Total	1987 Total	1988 Total	1989 Land	1989 Off.	1989 Total	1990 Land	1990 Off.	1990 Total
Canada	401	263	200	201	259	311	178	181	196	129	1	130	138	0	138
United States	2,910	3,970	3,105	2,232	2,428	1,980	964	936	936	764	105	869	902	108	1,010
North America	**3,311**	**4,233**	**3,305**	**2,433**	**2,687**	**2,291**	**1,142**	**1,117**	**1,132**	**893**	**106**	**999**	**1,040**	**108**	**1,148**
Argentina	76	70	67	73	82	81	47	61	63	54	1	55	63	1	64
Brazil	72	81	94	83	70	76	77	60	39	21	7	28	16	7	23
Mexico	215	218	202	187	196	196	163	143	155	69	34	103	57	33	90
Venezuela	52	63	69	41	30	33	29	18	25	18	10	28	20	12	32
Others	66	89	90	67	62	58	55	56	53	37	10	47	29	10	39
Latin America	**481**	**521**	**522**	**451**	**440**	**444**	**371**	**338**	**335**	**199**	**62**	**261**	**185**	**63**	**248**
Australia	16	23	33	25	34	31	15	16	19	7	7	14	8	6	14
India	43	44	50	56	57	62	70	116	131	110	25	135	110	27	137
Indonesia	77	86	92	88	82	80	62	37	44	36	10	46	36	16	52
Others	111	113	119	117	105	107	90	76	80	52	26	78	42	28	70
Far East	**247**	**266**	**294**	**286**	**278**	**280**	**237**	**245**	**274**	**205**	**68**	**273**	**196**	**77**	**273**
Algeria	111	91	81	54	27	35	41	40	32	24	0	24	35	0	35
Libya	41	33	31	24	26	30	20	12	16	13	4	17	12	3	15
Nigeria	20	23	27	17	11	10	10	11	13	10	4	14	12	6	18
Others	47	65	70	53	42	44	25	28	30	12	16	28	9	15	24
Africa	**219**	**212**	**209**	**148**	**106**	**119**	**96**	**91**	**91**	**59**	**24**	**83**	**68**	**24**	**92**
Germany, Fed. Rep.	22	26	31	25	19	20	19	12	9	8	0	8	8	1	9
Italy	19	32	38	26	26	40	33	26	24	17	5	22	16	5	21
Turkey	24	26	34	26	24	25	27	26	21	20	0	20	17	0	17
United Kingdom	48	58	58	42	60	63	43	44	57	4	42	46	2	46	48
Others	91	102	110	93	98	110	89	73	79	44	27	71	40	26	66
Western Europe	**204**	**244**	**271**	**212**	**227**	**258**	**211**	**181**	**190**	**93**	**74**	**167**	**83**	**78**	**161**
Abu Dhabi	23	31	41	35	29	21	15	9	7	2	4	6	4	5	9
Egypt	26	27	36	35	36	37	33	23	21	6	12	18	6	9	15
Saudi Arabia	25	29	29	26	16	11	6	5	4	4	1	5	9	1	10
Others	93	72	76	100	109	125	115	90	104	107	5	112	95	4	99
Middle East	**167**	**159**	**182**	**196**	**190**	**194**	**169**	**127**	**136**	**119**	**22**	**141**	**114**	**19**	**133**
Total Free World	**4,629**	**5,635**	**4,783**	**3,726**	**3,928**	**3,586**	**2,226**	**2,099**	**2,158**	**1,568**	**356**	**1,924**	**1,686**	**369**	**2,055**
Total excl. North America	**1,318**	**1,402**	**1,478**	**1,293**	**1,241**	**1,295**	**1,084**	**982**	**1,026**	**675**	**250**	**925**	**646**	**261**	**907**

Source: Baker Hughes Inc.

increasing production and exports. A substantial portion of the exports were to the non-communist countries. This added to the crude glut and increased the impact on OPEC.

The USSR is the world's largest producer. USSR output moved up 26% between 1975 and 1983. Their production fell 3% to 12.15 million bbl/d in 1985, and there was some question as to how long this level of production could be sustained. However, they did manage to boost production up to 12.56 million bbl/d in 1986 and 12.775 million bbl/d in 1987. Production moved up slightly in 1988 to 12.95 million bbl/d. The slide in USSR output started in 1989 as output slipped to 12.46 million bbl/d as some major production problems developed. Output slipped to 11.705 million bbl/d in 1990 and was down to 10.6 million bbl/d for the first half of 1991. Output is expected to fall below 10 million bbl/d by the end 1991.

The USSR has a program to replace internal oil consumption with natural gas. This policy is designed to free more oil for export to the West. In the past this has added an element to the excess capacity situation in the market-oriented world. This may be changing as USSR oil production falls. There are even some projections that they will become net oil importers in the future.

Chinese production has been moving up very gradually for a number of years. Output in 1990 moved up to 2.8 million bbl/d.

This was up only marginally from 2.79 million bbl/d in 1989. Production has been increasing since 1981 when it was 2.035 million bbl/d.

THE IMPACT OF EXCESS CAPACITY ON THE OIL MARKET. It is the massive excess capacity, which developed mainly in the OPEC countries, that has put a constant downward pressure on crude oil prices in recent years.

Recognizing the problem caused by the excess capacity, OPEC has tried to stabilize prices by establishing production quotas for individual countries and the group as a whole. However, few of the countries, other than Saudi Arabia, have exhibited the production discipline necessary to make the quotas work. The willingness of Saudi Arabia and a few other OPEC members to show some restraint managed to prevent a much-earlier free fall in prices. But even with a substantial effort on the part of Saudi Arabia, it was impossible to stabilize prices. Prices slipped slowly, dropping from 1981 through 1985.

Trying to prop up and stabilize prices in the face of the overhanging excess capacity is a complex matter. It encompasses the perceived value of oil on the part of the OPEC members, the cost of production, the cost and availability of competing fuels, and the internal politics of the OPEC members.

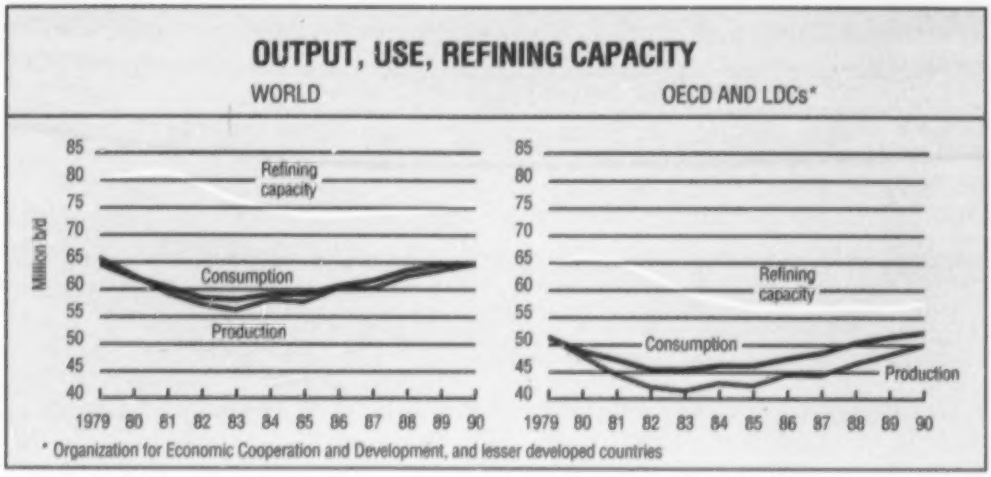
To get a better grasp of this problem, the following discussion points out some of the key factors that have an impact on the oil price/production situation. And the discussion will trace some recent OPEC decisions and their impact on the oil markets.

OPEC production, particularly in the Persian Gulf area, is some of the lowest cost in the world. But the aggressive pricing policies of OPEC in the 1970s and 1980s resulted in OPEC oil being the highest priced in the world for some time. Because of the high cost of OPEC oil during that period, the importing countries, whenever possible, replaced OPEC oil supplies with domestic crude or other less costly imported crude.

OPEC had become the swing producer filling the gap between demand and non-OPEC production. All excess capacity, except for some minor exceptions, was thrust upon OPEC. About 47% of installed OPEC capacity, 14 million bbl/d out of 30 million bbl/d was shut in during 1985. This improved slightly in 1986 and 1987 to 12 million bbl/d out of 30 million bbl/d, or 40% of installed OPEC capacity shut in. The increase in OPEC production in 1988 reduced the excess capacity to 9.8 million bbl/d. But this was still 33% of capacity. OPEC production moved up again in 1989 and cut the excess capacity to about 7 million bbl/d, 24% of total capacity. In 1990 OPEC crude production moved up to 23.3 million bbl/d and average capacity fell to 27.5 million bbl/d. This cut the OPEC excess capacity to 4.2 million bbl/d average for 1990. This was down to 15% of total capacity. By mid-1991 the excess capacity has been almost eliminated. Average OPEC crude oil production for the first half of 1991 is estimated at 22.93 million bbl/d. Capacity is estimated at 23.79 million bbl/d. This would mean excess capacity had been reduced to 860,000 bbl/d, only 3.6% of capacity.

The OPEC cartel pricing policies resulted in an oil industry turned upside down, with the cheapest production shut in and the most expensive production producing at full capacity.

OPEC AND MARKET FORCES. To get a clearer perspective on what has been happening in the world oil industry and with world oil prices, it might be advantageous to take a look from the viewpoint of classical economic theory.



In classical theory, price is the determinant of supply and demand. When external forces create a situation where there is not equilibrium, i.e., demand and supply do not meet at a market clearing price, then there are economic forces at work attempting to move the market toward equilibrium.

Prior to the establishment of OPEC, there was some evidence supporting the contention that the international oil companies held the price below the equilibrium price. This created a situation where excess demand developed. The oil companies met demand by concentrating on production. And pricing was based on current production costs. Little emphasis was given to the long run value of reserves in the ground. The result was a rapid increase in demand as cheap oil energy fueled economic expansion worldwide.

When OPEC gained control over production, they placed more emphasis on the long-term value and life of their oil reserves. They attempted to maximize immediate return rather than output. And they searched for the price level that the market would bear. To a certain extent, OPEC was using the world as a large economic laboratory to test the elasticity of demand for crude oil. The result of OPEC's pricing policy was a reduction in demand and increased supply, netting out to an excess supply situation.

However, market forces began to take hold and movement started toward reestablishing equilibrium. This movement took the form of falling prices, increased demand and a reduction in the rate of increase in the non-OPEC crude supply.

A brief review of what happened to prices during the past 15 years will help clarify this classical description. The official posted price of the OPEC market crude, Saudi Arabian Light crude oil, was boosted 294.2% from $2.75/bbl in 1973 to $10.84/bbl in 1974. The demand response was minimal at that time, since oil had been underpriced.

Then the price was moved up slowly to $12.70/bbl in 1978, an additional increase of 17.2%. However, because of the sharp increase in the rate of inflation, the real price actually fell during this period. Therefore demand for crude oil continued to move up even though the crude oil price had increased substantially. Demand is more responsive to the real price than the actual price since economic decisions to consume are based on the relative cost of an item compared to other necessary purchases.

Since demand was still rising, OPEC decided to raise prices again and test the market. This time, they boosted prices sharply from $12.70/bbl in 1978 to $34.00/bbl at the end of 1981, an additional increase of 167.7%. The overall price increase from 1973 through 1981 was $31.25/bbl, up 1,136.4%.

A price increase of that magnitude was bound to attract the attention of oil consumers. Demand reacted to this price increase. Oil consumption conservation, fuel switching to other energy, and a slow down in economic activity led to a 19% drop in production in the non-communist world between 1979 and 1983. This drop in demand for oil, coupled with the increase in non-OPEC production, resulted in the huge excess capacity in the OPEC countries.

This excess capacity put substantial downward pressure on prices. The official OPEC market crude price fell to $28/bbl in 1985, a reduction of 17.6% from the peak $34/bbl level. The average spot market price fell from $35.69/bbl in 1980 to an estimated $27.80/bbl in 1984, a drop of 22.1%. This fall in prices also got a reaction from fuel consumers. Free world demand responded to this sharp drop in prices and moved up 2.1% in 1984.

Another phenomenon occurred along with the development of a huge excess capacity. The growth in excess capacity led to a shift in trading from contract to the spot market. With crude readily available there was less need or advantage in long-term contracts.

When prices moved up sharply in 1979–1981, spot market prices were well above official prices. The average spot market price in 1979 was $12.60/bbl higher than the contract price. This difference undoubtedly prompted OPEC to push up the official price for their crude oil. With the development of the excess capacity, spot market prices fell below official prices and led to the drop in official prices.

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1989	Change 1989-1982	% change 1989/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	474.5	3.3	0.7
Ecuador	94.5	94.5	135.1	40.6	43.0
Gabon	44.0	44.0	20.0	−24.0	−54.5
Indonesia	473.4	473.4	751.3	277.9	58.7
Iran	1,320.0	670.0	766.0	96.0	14.3
Iraq	305.5	215.5	550.0	334.5	155.2
Kuwait	594.0	594.0	670.0	76.0	12.8
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	400.5	166.5	71.2
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	645.0	765.0	1,425.0	660.0	86.3
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,167.0	−156.1	−11.8
Total OPEC	**5,767.5**	**5,136.2**	**6,926.4**	**1,790.2**	**34.9**

Source: OPEC Statistical Bulletin

The volume of crude traded in the spot market grew substantially from 1981 to 1985. By 1985, the vast majority of transactions were spot market transactions or contract trades based on spot market prices. There has been some attempt to reestablish contract prices, but the volatile nature of prices has made this impossible. Instead, what has been established are crude supply contracts with the price based on some current market price indicator, such as spot market or futures market prices.

In addition to the shift to spot market trading, the more speculative nature of crude trading and prices resulted in the development of a futures market. This market has grown rapidly and is today one of the most watched indicators in the oil industry. In five years, the number of crude oil contracts traded on the New York Mercantile Exchange took off, with 350 million bbl in 1983, 1,840 million bbl in 1984, 3,981 million bbl in 1985, 8,314 million bbl in 1986, 14,582 million bbl in 1987, 18,518 million bbl in 1988, 20,665 million bbl in 1989, and 23,000 million bbl in 1990. More and more crude oil producers are using the futures market to reduce price risk, and this is expanding the market.

With the movement to spot market transactions, and the development of the

WORLDWIDE EXCESS PRODUCTIVE CAPACITY

	Production			Productive capacity*			Excess capacity				
	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	% of total capacity	% of total production
	(1,000 b/d)										
1961	9,364	9,319	18,683	10,150	10,050	20,200	786	731	1,517	7.51	8.12
1962	10,508	9,663	20,171	11,350	10,450	21,800	842	787	1,629	7.47	8.08
1963	11,514	10,036	21,550	12,450	10,850	23,300	936	814	1,750	7.51	8.12
1964	12,984	10,206	23,190	14,050	11,050	25,100	1,066	844	1,910	7.61	8.24
1965	14,339	10,552	24,891	15,500	11,400	26,900	1,161	848	2,009	7.47	8.07
1966	15,770	11,235	27,005	17,050	12,150	29,200	1,280	915	2,195	7.52	8.13
1967	16,850	12,155	29,005	18,200	13,150	31,350	1,350	995	2,345	7.48	8.08
1968	18,786	13,114	31,900	20,300	14,200	34,500	1,514	1,086	2,600	7.54	8.15
1969	20,907	13,569	34,476	22,600	14,650	37,250	1,693	1,081	2,774	7.45	8.05
1970	23,413	14,515	37,928	25,300	15,700	41,000	1,887	1,185	3,072	7.49	8.10
1971	25,326	14,575	39,901	27,400	15,750	43,150	2,074	1,175	3,249	7.53	8.14
1972	27,094	14,845	41,939	29,300	16,050	45,350	2,206	1,205	3,411	7.52	8.13
1973	30,989	14,942	45,931	33,500	16,150	49,650	2,511	1,208	3,719	7.49	8.10
1974	30,729	14,593	45,322	34,800	15,750	50,550	4,071	1,157	5,228	10.34	11.54
1975	27,155	14,418	41,573	36,100	15,600	51,700	8,945	1,182	10,127	19.59	24.36
1976	30,738	14,548	45,286	37,400	15,750	53,150	6,662	1,201	7,863	14.79	17.36
1977	31,278	15,595	46,873	38,700	16,850	55,550	7,422	1,255	8,677	15.62	18.51
1978	29,805	17,304	47,109	36,480	18,700	55,180	6,675	1,396	8,071	14.63	17.13
1979	30,928	17,708	48,636	34,260	19,150	53,410	3,332	1,442	4,774	8.94	9.82
1980	26,890	18,310	45,200	32,730	19,800	52,530	5,846	1,484	7,330	13.95	16.21
1981	22,624	18,853	41,477	31,200	20,400	51,600	8,576	1,547	10,123	19.62	24.41
1982	18,584	19,768	38,352	31,200	21,400	52,600	12,616	1,632	14,248	27.09	37.15
1983	17,317	20,718	38,035	31,200	22,400	53,600	13,883	1,682	15,565	29.04	40.92
1984	17,442	21,922	39,364	31,000	23,700	54,700	13,558	1,778	15,336	28.04	38.96
1985	16,039	22,727	38,766	30,000	24,400	54,400	13,961	1,673	15,634	28.74	40.33
1986	18,074	22,443	40,517	30,000	24,550	54,550	11,926	2,107	14,033	25.73	34.63
1987	17,801	22,532	40,333	29,500	24,800	54,300	11,699	2,268	13,967	25.72	34.63
1988	19,665	22,744	42,409	29,500	24,700	54,200	9,835	1,956	11,791	21.75	27.80
1989	22,010	22,338	44,348	29,000	24,500	53,500	6,990	2,162	9,152	17.11	20.64
1990	23,347	22,584	44,931	27,500	25,500	53,000	4,153	2,916	7,069	13.34	15.39

*Estimated total available capacity

futures market, OPEC lost a lot of control over pricing. They had a market with higher oil prices but no longer the control over prices like the international oil companies once had.

In an attempt to prevent a collapse of prices, OPEC established production quotas for each member country. OPEC set a production quota in 1983 of 17.5 million bbl/d. However, prices continued to slide, and the production quota was reduced to 16 million bbl/d in 1984. There was considerable cheating, with a number of OPEC countries producing above their quotas.

At that time Saudi Arabia was willing to play the role of swing producer, and they cut production sharply in order to support the worldwide price. Playing the role of swing producer Saudi Arabian production fell 6.39 million bbl/d, 64%, from 9.99 million bbl/d in 1980 to 3.6 million bbl/d in 1985. Other OPEC producers showed some production restraint, and the result was a sufficient reduction in total production to prevent a free fall in prices.

In order to prop up prices, Saudi Arabia was forced to shut in a substantial volume of production. After awhile it became apparent that they were absorbing a disproportionate percentage of the production cutback that was required to support prices.

In the summer of 1985, playing the role of swing producer forced Saudi Arabian production temporarily below 2 million bbl/d. And it became apparent that with expected weak demand in 1986, their production would fall even further if they continued to be the supply source of last resort.

So in the fall of 1985 the Saudis unilaterally arranged, with several selected purchasers, to sell their oil using a new net-back pricing arrangement. They were willing to accept a lower price for their crude oil that was based on the net-back value of the crude oil after product sales and refining. This was done by the Saudis in order to increase their share of

OPEC PRODUCTION QUOTAS

(1,000 b/d)

Country	1984* quota	1984 production	1988 quota	1988 production	1989* quota	1989 production	1990 quota	1990 production
Algeria	663	608	667	641	771	714	827	794
Ecuador	183	258	221	305	254	279	273	286
Gabon	137	150	159	175	184	211	197	274
Indonesia	1,189	1,423	1,190	1,138	1,374	1,235	1,374	1,289
Iran	2,300	2,174	2,369	2,240	2,926	2,947	3,140	3,136
Iraq	1,200	1,210	1,540	2,688	2,926	2,897	3,140	2,080
Kuwait	900	945	996	1,335	1,149	1,593	1,500	1,079
Libya	990	1,091	996	1,025	1,149	1,130	1,233	1,374
Neutral Zone	†	439	†	313	†	397	†	312
Nigeria	1,300	1,414	1,301	1,390	1,501	1,672	1,611	1,804
Qatar	280	396	299	346	346	387	371	393
Saudi Arabia	4,353	4,464	4,343	4,946	5 014	4,995	5,380	6,302
United Arab Emirates	950	1,159	948	1,474	1,094	1,866	1,500	2,117
Venezuela	1,555	1,711	1,571	1,649	1,812	1,725	1,945	2,107
Total	**16,000**	**17,442**	**16,600**	**19,665**	**20,500**	**22,048**	**22,491**	**23,347**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates

WORLDWIDE EXPORT CRUDE OIL PRICES

Official Sales and Term Contract Prices (Dollars per barrel - 1 January)

Year	Saudi Arabia Arabian Light 34°	Nigeria Bonny Light 37°	United Kingdom Brent 38°	Mexico Isthmus 33°	U.S.S.R. Export Blend 32°
1979	13.34	14.80	15.70	14.10	13.20
1980	26.00	29.97	26.02	32.00	33.20
1981	32.00	40.00	39.25	38.50	39.25
1982	34.00	36.50	36.60	35.00	35.49
1983	34.00	35.50	33.50	32.50	31.20*
1984	29.00	30.00	30.00	29.00	28.60
1985	29.00	28.00	28.65	29.00	28.00
1986	28.00	28.65	26.00	26.21	28.15
1987	16.15	17.13	18.25	17.00	18.30
1988	17.52	18.92	18.00	14.83	15.80
1989	13.15	15.05	15.80	14.53	14.55
1990	18.40	21.20	21.00	19.90	20.25
1991	24.00	27.80	27.20	24.80	26.05

Source: Energy Information Administration

the crude oil market and to send a message to the other OPEC producers. It was a message that they would no longer carry the entire burden of supporting prices. They abandoned the role of swing producer and have not returned to it.

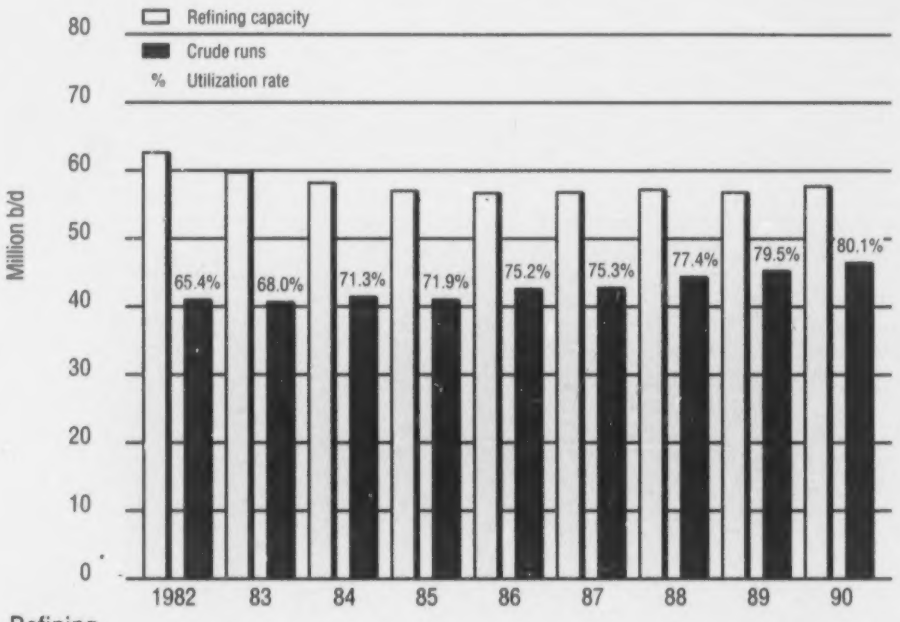
In a subsequent OPEC meeting in 1985, OPEC policy was also changed to one aimed at regaining market share, rather than supporting prices. This turned out to be a disaster. This shift in OPEC policy brought the full weight of the excess crude capacity bearing down on worldwide crude oil prices. The result was a collapse in the price of crude oil in early 1986, when winter demand began to slacken.

The average price of world export crude fell from $27.10/bbl at the end of 1985 to a low of $9.35/bbl the first week of August 1986, a drop of 65%. This did stimulate demand for OPEC oil. And it did curtail investment in, and in some cases production of, competing high cost oil. OPEC did achieve the goal of increased market share. But there was a huge cost associated with the increase in market share, since the drop in prices far exceeded the increase in demand for OPEC oil.

OPEC found out that there was a tremendous cost to pay when gaining market share at the expense of the price level. August production in 1986 at 21.028 million bbl/d was up 38.6% over August 1985. And cumulative production for the first eight months of 1986 was up 19.9% from 1985. But prices had fallen 65%, and it was obvious that increased volume could not make up for lost revenue due to lower prices. If OPEC wanted increased market share it would be at the cost of substantially lower revenues.

The total value of OPEC crude exports had fallen from $282 billion in 1980 to $132 billion in 1985, a drop of 53.4%. Revenues for

OECD and LDCs* REFINING CAPACITY AND CRUDE RUNS



	1982	83	84	85	86	87	88	89	90
Refining capacity	62.8	59.8	58.1	57.0	56.7	56.9	57.1	56.9	57.7
Crude runs	41.0	40.7	41.4	41.0	42.6	42.8	44.2	45.2	46.3

* Organization for Economic Cooperation and Development and lesser developed countries
Source: British Petroleum

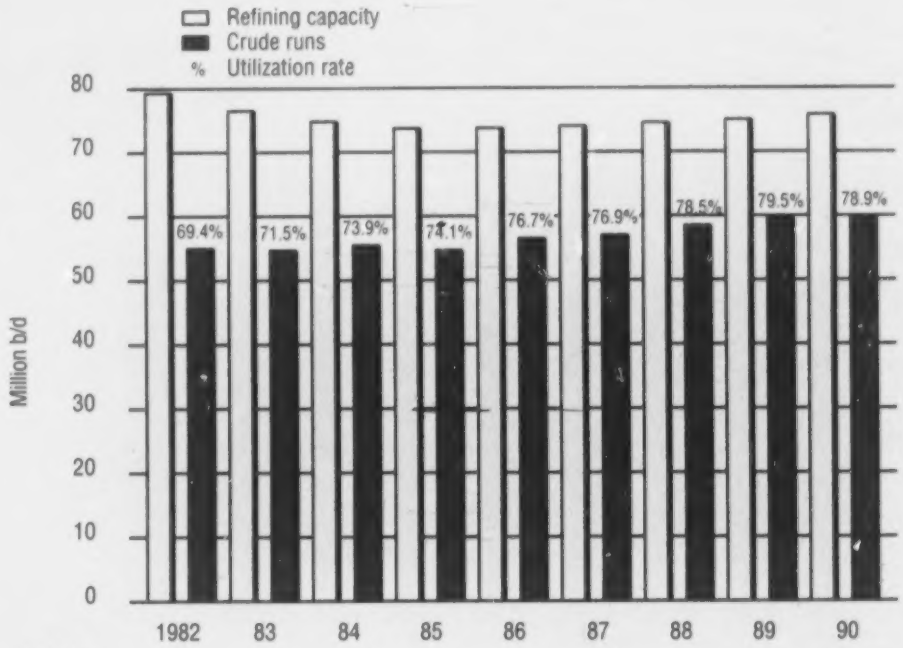
1986 fell another 42% to $77 billion. The policy of trying to gain a greater market share cost OPEC $56 billion in revenue. This was sufficient incentive to establish a workable quota agreement.

With the new quotas, OPEC production dropped in 1987, about 2.7%, but estimated revenues were up substantially. Estimated revenues increased about 13% to $87 billion.

In prior years OPEC wasn't able to establish group production discipline. Due to the lack of discipline, Saudi Arabia abandoned the role of sole swing producer. The result was a collapse in prices in the spring of 1986. OPEC supposedly learned a lesson from this experience. Quotas were reestablished and prices moved back up in 1987.

But the lesson wasn't learned very well and 1988 in many ways turned out to be a repeat of 1986, although the price collapse wasn't quite as severe. In 1988 as in 1986 OPEC found it very difficult to sustain production discipline with that huge excess production capacity readily available. In 1988,

TOTAL WORLD REFINING CAPACITY AND CRUDE RUNS



	1982	83	84	85	86	87	88	89	90
Refining capacity	79.2	76.5	74.9	73.8	73.8	74.1	74.5	74.9	75.8
Crude runs	55.0	54.7	55.4	54.7	56.6	57.0	58.5	59.6	59.8

Source: British Petroleum

overproduction again weakened prices. A number of OPEC countries boosted output over the quota and prices fell. The average export price of OPEC crude oil fell from $16.35/bbl in January of 1988 to $10.75/bbl in October. It appeared that the lesson of market economics had to be learned all over again.

OPEC established new, more realistic production quotas starting in January 1989. And some of the countries that were overproducing exhibited sufficient discipline to tighten the market and help firm up prices. In addition, OPEC was helped by rising demand that was stimulated by the low prices. This helped clear the market and support prices at a higher level. Prices moved up to $15.04/bbl in January 1989 and to $18.24/bbl in April. For the remainder of the year export prices remained relatively stable, moving between $15.50/bbl and $17.50/bbl.

During 1990 the average worldwide export price of crude oil slipped throughout the first half of the year falling from $19.93/bbl the first week of January down to $13.09/bbl the last

WORLDWIDE GAS RESERVES

	Jan. 1					Change	% change
	1978	1983	1988	1990	1991	1991-1978	1991/1978
	(Billion cu ft)						
Australia	32,000	17,768	18,610	16,467	15,433	−16,567	−51.8
China	25,000	29,800	30,700	35,300	35,300	+10,300	+41.2
India	3,500	14,508	17,550	22,973	25,049	+21,549	+615.7
Indonesia	24,000	29,600	73,000	87,015	91,450	+67,450	+281.0
Malaysia	17,000	34,000	52,200	51,900	56,900	+39,900	+234.7
Pakistan	15,500	18,540	22,400	18,000	19,449	+3,949	+25.5
Thailand	4,500	11,000	3,720	6,910	5,850	+1,350	+30.0
Others	26,225	20,831	37,320	44,766	49,130	+22,905	+87.3
Total Asia-Pacific	**147,725**	**176,047**	**255,500**	**283,331**	**298,561**	**+150,836**	**+102.1**
Netherlands	60,000	51,920	64,100	61,100	60,900	+900	+1.5
Norway	20,000	58,000	105,940	82,160	60,674	+40,674	+203.4
United Kingdom	29,000	25,400	22,000	20,836	19,775	−9,225	−31.8
Others	28,330	21,961	26,140	27,818	33,916	+5,586	+19.7
Total Western Europe	**137,330**	**157,281**	**218,180**	**191,914**	**175,265**	**+37,935**	**+27.6**
U.S.S.R.	920,000	1,240,000	1,450,000	1,500,000	1,600,000	+680,000	+73.9
Others	11,400	14,000	29,300	28,000	19,000	+7,600	+66.7
Total E. Europe & U.S.S.R.	**931,400**	**1,254,000**	**1,479,300**	**1,528,000**	**1,619,000**	**+687,600**	**+73.8**
Abu Dhabi	20,000	19,260	183,500	182,900	182,800	+162,800	+814.0
Iran	500,000	482,600	489,400	500,000	600,350	+100,350	+20.1
Iraq	28,000	28,800	26,300	95,000	95,000	+67,000	+239.3
Kuwait	31,500	29,900	36,400	48,600	48,600	+17,100	+54.3
Qatar	40,000	62,000	156,700	163,100	163,200	+123,200	+308.0
Saudi Arabia	85,000	117,000	139,900	181,347	180,355	+95,355	+112.2
Others	14,620	29,625	51,830	55,203	53,960	+39,340	+269.1
Total Middle East	**719,120**	**769,185**	**1,084,030**	**1,226,150**	**1,324,265**	**+605,145**	**+84.2**
Algeria	125,000	111,250	105,900	114,000	114,700	−10,300	−8.2
Libya	25,700	21,500	25,700	25,500	43,000	+17,300	+67.3
Nigeria	43,000	32,400	84,000	87,400	87,400	+44,400	+103.3
Others	13,804	24,273	33,030	39,830	40,043	+26,239	+190.1
Total Africa	**207,504**	**189,423**	**248,630**	**266,730**	**385,143**	**+77,639**	**+37.4**
Argentina	8,120	25,200	23,600	27,299	27,000	+18,880	+232.5
Canada	58,000	97,000	98,000	94,300	97,589	+39,589	+68.3
Mexico	30,000	75,850	76,530	73,380	72,744	+42,744	+142.5
Trinidad & Tobago	8,500	11,000	10,390	9,968	8,910	+410	+4.8
United States	208,878	201,512	187,211	165,000	166,208	−42,670	−20.4
Venezuela	41,000	54,079	95,000	100,846	105,688	+64,688	+157.8
Others	20,860	20,462	21,140	22,201	27,942	+7,082	+34.0
Total Western Hemisphere	**375,358**	**485,103**	**511,871**	**492,994**	**506,081**	**+130,723**	**+34.8**
Total World	**2,518,437**	**3,031,039**	**3,707,511**	**3,969,119**	**4,208,315**	**+1,689,878**	**+67.1**
Total OPEC	**977,150**	**1,010,674**	**1,452,720**	**1,620,158**	**1,744,583**	**+767,433**	**+78.5**
OPEC as % of World	38.8%	33.3%	38.3%	40.6%	41.5%	—	—

Source: Oil & Gas Journal

week of June. Prices began to move up on the strength of stocking for winter demand and some OPEC production discipline. Prices moved up to $16.60/bbl the last week of July. Following the Iraq invasion of Kuwait, prices moved up rapidly and reached a high of $36.11/bbl the last week of September. Prices remained elevated for the remainder of the year but slipped from the peak when it became apparent that there would not be a major shortage. The price averaged $21.35/bbl for the year, up 28.2% from 1989.

Prices slipped again in 1991 following the war. The average price slid to $15.34/bbl by the first week of March. However prices then moved up and stayed in a relatively narrow range through August, from $15.57/bbl to $17.51/bbl.

PRICING CRUDE OIL. It appears quite apparent that the key to establishing a price for crude or just stabilizing crude prices is the

OPEC adherence to a reasonable quota. This is evident from the events of 1986 through 1989, when crude prices moved through a couple of major cycles.

OPEC abandoned their attempt to increase world market share by reestablishing production quotas in late 1986. First they adopted a set of temporary emergency quotas in September 1986 to stop the free fall in crude prices. And then they adopted a more formal set of quotas at the end of 1986 to help sustain a higher price level.

The average price of OPEC export crude fell from $27.81/bbl at year end 1985 to $9.59/bbl in August 1986, during the OPEC experiment with attempting to increase market share. When OPEC announced that they were adopting temporary quotas, the price moved back up to $12.50/bbl and remained between $12.30/bbl and $14.70/bbl for the remainder of 1986. Following the adoption of formal quotas in December 1986, the average price of OPEC export crude moved up over $17/bbl. And the price stayed above $17/bbl for all of 1987. The key to the higher price level was the adoption and adherence to the quotas and the abandonment of net-back pricing.

Under net-back contracts, the price of the crude traded is based upon the value or selling prices of the refined products. The value of the products that can be obtained from the specific type of crude oil are determined by the sales price during a specified time period. From this value are deducted the costs associated with refining the products, transporting the crude, and a specified processing fee or refiner margin. The remainder is the net-back value or price of the crude and represents the amount remitted to the producer. Net-back pricing shifts a great deal, if not all, of the price risk in the market to the producer.

Under net-back pricing, refiners had a great deal of incentive to try to move large volumes of product by price competition. Under most net-back formulas, refiners were virtually guaranteed a profitable margin on each barrel. So the incentive was for the refiner to increase the volume sold. The result was rapidly declining prices along with increased product demand and increased demand for crude oil.

For a time it appeared that OPEC was trying to reestablish the old posted price system. But as could be expected not many purchasers were willing to commit to any long-term contracts in the current volatile market. OPEC export prices were rather stable for an extended period in 1987, but this was mainly due to market conditions rather than an acceptance of posted prices by the crude purchasers. The adherence to production levels close to the adopted OPEC quotas brought supply and demand close to equilibrium and stabilized prices.

OPEC may have regained some control over the market and the price of oil in 1987. But that control was dependent upon their ability to establish a quota that would tighten supply in the market. And it was dependent upon OPEC countries having the long-term discipline to constrain production levels. They flunked the test in 1988 by overproducing and driving down the price. And again it cost them revenue.

The key to price stability is the level of OPEC production discipline and the selection of a quota that can sustain equilibrium between supply and demand. OPEC managed to do this fairly well in 1989, but they were helped out by higher than expected worldwide demand. The production discipline eroded somewhat in the first half of 1990 and prices slipped. OPEC was attempting to reestablish some quota discipline when the Iraqi invasion of Kuwait took place.

In 1991 OPEC had an easier time establishing production discipline and setting a quota that will balance the market. OPEC set a

production quota of 22.3 million bbl/d. The quota does not include any production from Iraq or Kuwait. The OPEC total capacity is estimated at only 23.8 million bbl/d so there is not a great deal of room for excess production. This has enabled OPEC to maintain output at a level that appears to have stabilized the market.

SUPPLY VULNERABILITY. These outlooks are based upon expectations due to economic forces and don't attempt to forecast political events. But political upheavals do have an impact on worldwide supply. This became very obvious due to the Iraq invasion of Kuwait and the subsequent war in the Persian Gulf.

Of most concern in the past has been the possible closing of the Strait of Hormuz due to some conflict in that area. This was of particular concern during the Iran-Iraq war. This was of great concern since there was considerable action directed at tanker traffic during that conflict. With the cease-fire between Iran and Iraq, the probability of a closure of the Strait was reduced substantially.

Dependency upon imports through the Strait of Hormuz had been reduced in recent years. Reduced worldwide imports and alternative pipeline routes that bypass the Strait reduced the vulnerability. However, imports are on the rise again and this will add to vulnerability. In 1990 an estimated 9.4 million bbl/d, 29.9% of world exports, were coming through the Strait. Total world import/exports are estimated at about 31.4 million bbl/d. A substantial portion of world imports would be affected if the Strait was closed.

Saudi Arabia has increased the capacity of their pipeline system to the Red Sea. Saudi Arabia presently has the capacity to move close to 4 million bbl/d via their pipeline system. If they fully utilized this capacity it would substantially reduce the flow through the Strait.

Although it appears that vulnerability has been reduced because of the end to the wars in the area, this will continue to remain a strategic channel for world oil supply. United States imports are increasing rapidly, and this is therefore boosting the volume of crude and products in international trade. And even though some alternative routes have been developed, it is probable that crude moving through the Strait will increase. Several Persian Gulf producing countries are planning to boost output. This includes Saudi Arabia, Iran, and the United Arab Emirates. In addition, at some time in the future Iraq will probably reestablish an export terminal in the Gulf. These moves will add substantially to the volumes moving through the Strait.

If the Strait was closed for any reason the impact on prices would depend upon the perceived length of time it would be closed. If it appeared that the closing was only temporary, the industrial countries and international oil companies might simply draw down stock levels to meet the demand. However, industry stock levels are presently quite low and do not offer much of a buffer against a major supply disruption. However, strategic government stocks might be used if there were a temporary disruption.

It is still an area of vulnerability, but there is presently little thought given to a potential closing, and it doesn't appear to have much impact on industry decisions. However, the closing of the Strait for any length of time would shut in a massive volume of production and cause chaos to the world industrial economies.

EXPLORATION. The search for oil throughout the non-communist world, outside the United States, has not been fluctuating as wildly as crude oil prices. Oil importing countries find it financially advantageous to develop their own

NET BACK PRICING EXAMPLE

	$/barrel
Product revenues	18.50
Less: refining costs	2.50
Less: processing/handling fee	2.00
Less: transport cost	1.50
Net back price of crude*	**12.50**

*The net back value varies depending on product revenues and costs

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports	Product exports (1,000 b/d)	Total exports	Value of exports ($ million)	Average value ($/bbl)
1980	22,864.1	2,008.6	24,872.7	284,491	31.25
1981	18,568.8	1,979.3	20,548.1	263,336	35.11
1982	14,296.1	2,225.7	16,521.8	202,791	33.63
1983	12,506.5	2,023.1	14,529.6	156,944	29.59
1984	12,043.9	2,281.3	14,325.2	143,569	27.38
1985	10,926.4	2,368.2	13,294.6	127,180	26.21
1986	12,939.8	2,642.0	15,581.8	76,739	13.49
1987	12,060.4	3,017.2	15,077.6	92,601	16.83
1988	13,367.0	3,395.3	16,762.3	85,933	14.01
1989	15,128.8	3,599.5	18,728.3	116,646	17.06
Average	**14,470.2**	**2,554.0**	**17,024.2**	**155,023**	**24.95**

Source: OPEC Statistical Bulletin

crude capacity. And in addition the international oil companies have found that there is substantially more profit margin in equity crude than in crude purchased from OPEC exporters. So they have continued the search in those areas where they can obtain favorable and profitable exploration/development agreements.

The result has been an active drilling rig count, outside the United States and Canada, that has held up fairly well during the recent period of falling or wildly fluctuating prices. This number of active drilling rigs peaked in 1982 at 1,479. The active rig count fell to 1,292 in 1973 and 1,239 in 1984 but then went back up to 1,293 in 1985. The rig count did fall 16.2% to an average 1,084 in 1986. However, this was less than half of the 35–40% drop in average crude oil prices. The count did slip again in 1987, to an average of 981 for the year. But by year end it had moved back up to 1,050. And the average for 1988 increased to 1,028. This is comparable to 1978 when the count averaged 1,086. The international rig count fell again in 1989 and averaged only 925. Drilling dropped sharply in a few of the countries with internal financial problems. The international rig count continued to slide in 1990. The average number of active rigs dropped to 907 rigs for 1990. Compared to the peak year of 1982, the international rig count for 1990 was down 38.6%. The price of crude oil on the other hand was down 37%.

The rig count in mid-1991 was down slightly from the year before, but expectations are that it would average slightly higher for the year. There is an expectation that the stable prices will act to stimulate additional drilling.

Up until the collapse in prices in 1986, one of the major reasons for the high level of activity in the face of declining demand was the relatively high price of oil. The increase in the price of oil had far surpassed the general rate of inflation during the past decade. Therefore the profit margin on projects had increased considerably. Previously uneconomic or marginal fields were being developed throughout the world, and huge import bills encouraged countries without sufficient production to stimulate exploration activities.

One major result of this high level of exploration activity has been to prevent a major decline in worldwide crude reserves. In fact, coupled with the decline in demand/production, the increased exploration has resulted in an increase in reserves.

Looking to the future, as oil becomes more difficult to find, particularly in large quantities, activity must increase in order to maintain reserves. This is particularly true in the non-OPEC areas. And the level of activity will be sustained and increased only if the price level moves up. However, this does not appear to be an immediate problem. Total worldwide crude oil reserves were increased substantially during 1987, 1988, and 1989. Reserves slipped marginally in 1990. Reserves at the start of 1991 were up 43.2%, an increase of 302 billion barrels from four years earlier. Reserves as of January 1, 1991 were 999 billion

barrels. Huge revisions and additions were made by five OPEC countries, Venezuela, United Arab Emirates, Iraq, Iran, and Saudi Arabia. This accounted for most of the massive increase over the last few years.

One of the results of this substantial addition is that worldwide reserves at the start of 1991 were 54.1% higher than they were 10 years earlier at the start of 1981. OPEC reserves at the first of 1991 were 774 billion barrels, which is 77.5% of total world reserves.

The worldwide reserves/production ratio was 35.2 years in 1975. This fell to 26.7 years in 1979, the year of peak worldwide production. In 1984 the ratio moved up to 31.7 years. With the huge upward revisions in reserves, this moved up to an estimated 42.7 years in 1988, 42.9 years in 1989, 46 years in 1990, and 45.3 years for 1991.

Worldwide reserves have been replaced and even increased throughout the past 10 years. This was mainly due to the increased value of oil that stimulated increased exploration activity. The reserves/production ratio has been maintained, and there is no apparent immediate pressure on oil availability. However, investment in exploration and production activity will have to be sustained if the reserves/production ratio is to be maintained at this level.

It is evident from the reserves profile that OPEC still holds the key position in future world supply. And unless activity is sustained in the non-OPEC areas, the OPEC dominance over production and prices will be reestablished in the near future. It is evident that in the long run OPEC holds the reserve position to dominate the world oil industry.

REFINING. Another key element of the supply side of the equation is refining. The worldwide refining industry has gone through a somewhat similar cycle to that of production. That cycle also has been brought on by the volatile change in prices.

With the drop in demand for petroleum products, crude runs in refineries also fell sharply. As refinery runs fell, excess capacity developed in the refining industry. Refining capacity represents a substantial fixed investment in plant and equipment. Therefore, adjustment of capacity to the declining demand was a slow process.

There was an initial delay in reducing refining capacity as refineries attempted to determine if the peaking of demand, and subsequent decline, was a temporary phenomenon; or determine if it was a permanent demand adjustment that would require adjustment in refining capacity. Based on the long-term forecasts available at that time that projected steadily increasing long-term demand, refineries initially adjusted by running at a lower utilization rate. As it became apparent that the downturn in demand was signaling a much lower long run level of demand, refineries realized that the industry was faced with a massive excess capacity.

Faced with sharply reduced, and in many cases, negative refining margins, refiners started to adjust capacity by mothballing or permanently closing facilities. Non-communist refining capacity peaked in 1980 at 65.7 million bbl/d and remained relatively high in 1981 at 65.14 million bbl/d. After those years of research, capacity was reduced at a more rapid rate and fell to 56.135 million bbl/d in 1986. Capacity fell again in 1987 to 55.75 million bbl/d and was down 9.95 million bbl/d, 15.1%, from the peak in 1980.

The slide in capacity was slowed in 1988. Demand for petroleum products has been on the rise in recent years. In response, non-communist refining capacity moved up to 56.550 million bbl/d in 1988, stopping the seven-year slide. Increased demand led to additional capacity being added in the United States. There were also net capacity additions

in the Middle East and Africa. These additions more than offset reductions elsewhere.

The slide in refining capacity continued in 1989 with a 1.1% drop to 55.9 million bbl/d. United States and Canadian capacity was reduced again. Capacity in Western Europe and the Middle East also declined. This was partially offset by increases in Latin America, Africa, and the Far East.

Refining capacity in the formerly called *communist* areas of China, USSR, and Eastern Europe has been moving up steadily. Capacity in the USSR increased to 12.3 million bbl/d in 1989. Capacity in Eastern Europe moved up 7.3% in 1989 to 3.42 million bbl/d. And refining capacity in China climbed 5.5% in 1989 to 2.47 million bbl/d.

Total worldwide refining capacity move up 1.1% to 75.775 million bbl/d in 1990. Capacity in the Middle East moved up 12.7% to 5.05 million bbl/d. Capacity in Asia and Australia also move up, increasing 2.5% to 12.98 million bbl/d.

The reduction in demand for petroleum products in the early 1980s led to a drop in refinery throughput. And this resulted in a sharp drop in the refinery utilization rate. The refinery utilization rate for non-communist world refineries fell to 65.4% in 1982, from 74.3% in 1978. A lower utilization rate increases the unit cost of refined products and reduces refining margins. This was a great incentive to adjust refining capacity in an attempt to increase profitability.

A cut in crude refining capacity, and an increase in demand, boosted the rate up to 75.3% in 1986. It moved up to 76% in 1987 due to the increase in throughput and decline in capacity. This increased to 77.3% in 1988 as the 2.9% increase in throughput surpassed the 1% increase in capacity. The capacity utilization rate moved up again in 1989 to 80% as capacity declined and crude runs increased. The utilization rate stayed at 80% in 1990.

The utilization rate in the USSR and Eastern Europe is somewhat lower and falling, 78.1% in 1988, 76% in 1989, and 72.8% in 1990.

The improvement in the non-communist area utilization rate over the last several years was primarily due to the reduction in capacity. But in the last several years, 1986 through 1989, increased throughput due to the improvement in demand made a major contribution to the improvement in the utilization rate.

This improvement in refining utilization has improved profitability in the refining sector of the industry. However, now there is another threat to refining profitability emerging, and that is the increase in OPEC refining capacity. It appears apparent that some of the OPEC countries intend to carve out a portion of the refined products market. OPEC has plans to increase their refining capacity substantially. OPEC countries will not only be supplying a much greater percentage of their own internal petroleum product requirements but also will be expanding their role in the product export market.

Offsetting these expansions, however, is the damage that was done to the refining capacity of Kuwait and Iraq during the Persian Gulf War.

OPEC's refining capacity was 6.926 million bbl/d in 1989, up 34.9% from 1982. As consumption grows in the OPEC countries, it is likely that refining capacity will be added. And it is probable that additional capacity will be added to supply products for export.

This may really be one of the major issues of concern to the world oil industry in the future. The major international oil companies have lost control over a substantial portion of world crude production. Now they will be meeting competition from OPEC in refining. This is probably also of concern to the major industrial countries. A great deal of rev-

enue is derived from taxes on refined products. If OPEC is able to capture a portion of the refined product market, they may capture the revenue now collected as taxes by the industrial countries, or substantially drive up the prices of refined products.

Several of the major OPEC producing countries also have adopted a new strategy. Venezuela, Kuwait, and Saudi Arabia have made substantial investments in downstream refining and marketing facilities in the industrial countries. They appear to be trying to establish major fully integrated operations in these areas, similar to the major international oil companies. They are seeking secure markets for their crude and also trying to capture some of the profit from these downstream activities.

Refiners also play a major role in the maintenance of crude and petroleum product stock levels. And stock levels play a major role in determining short run and seasonal swings in crude demand and prices.

When the turnaround started, in 1980 and 1981, the reluctance of refiners to adjust immediately to the initial drop in demand, coupled with a reluctance to break long-term contractual agreements for crude from export nations, resulted in a huge buildup of stocks. Stocks for the OECD group of countries increased 465 million bbl from year end 1978 to year end 1980 and peaked at 3,587 million bbl at the end of 1980.

Refiners originally retained the high stock levels as a buffer against a potential supply disruption and a rebound in demand. But the acceleration in worldwide inflation brought high interest rates that translated into very high carrying costs for the excessive inventories. With depressed margins and sharply reduced profits, it was essential that action be taken to reduce these costs.

Refiners found it difficult to reduce stocks in the face of falling demand, but they made a concentrated effort by breaking long-term crude supply agreements. This forced stocks back into the ground by reducing off-takes (or the rate of production) from the producing countries. From 1980 to 1985, stocks of the OECD countries were reduced 301 million bbl. These were all private stocks in the hands of refiners and marketers. Public/government stocks such as the United States Strategic Petroleum Reserve continued to be increased however. Those stocks represent a government-financed buffer to protect against supply disruptions.

With increased demand and the continued build up in government stocks, total stocks moved up in 1986 and 1987. Stocks remained at about the same level in 1988 and 1989. Stocks were boosted in 1990 as refiners built inventories as a contingency against a supply disruption in the Persian Gulf.

Part of the build up in recent years also is due to the lower crude prices. It is not as costly at present for refiners to hold stocks as a contingency. However, refiners have developed an efficient system and are able to operate with a much lower stock level than in previous years. It now appears that refiners have reached an acceptable balance between demand and stocks and therefore have stopped their inventory drawdown. And with demand on the rise, refiners are adding to stocks to maintain a demand and stocks balance and avoid any supply shortages. Refiners have to keep a minimum level of stocks in order to operate efficiently.

Sharp fluctuations in price can cause refiners to moderate this operating philosophy. When prices drop they generally build inventories to take advantage of the low cost crude. And if prices move up rapidly, there is a tendency for refiners to reduce inventories and minimize costs.

NATURAL GAS. There are several major energy sources that provide the fuel for economic activity. This must be taken into consideration when analyzing the demand/consumption of oil and energy. Over the past 10 years, the level of worldwide oil production has been influenced primarily by the price of oil, but competition from competing fuels has been a factor also.

One of the major competing fuels has been natural gas. And natural gas is growing in importance as a fuel throughout the world.

Total world production in 1990 was 69.1 trillion cubic feet. This was up 2% from 1989 and up 35.2% from 1989. Production in the OECD and developing countries was 41.3 trillion cubic feet in 1990. This was up 18.1% from 1980. Production from the USSR and Eastern Europe posted an increase of 74.2% during the 10 years 1980–1990. Production was to 26.6 trillion cubic feet in 1990. All of the increased production was in the USSR with 1990 production of 25.1 trillion cubic feet, up 82.3%, over the 10 years. The USSR passed the United States in 1983 to become the world's largest natural gas producing country.

All of this production is not consumed in the USSR or in Eastern Europe. The USSR has recently been exporting large volumes of gas to Western Europe. They have been concentrating a lot of resources on developing natural gas. In addition to exports, they have adopted a policy of transforming segments of their economy from oil consuming to natural gas. This enables them to export greater volumes of crude oil and obtain hard currency for foreign trade. Their plentiful reserves enable them to pursue both of these objectives.

World trade movements of natural gas totaled 8.2 trillion cubic feet in 1990. Exports from the USSR accounted for 47.3% of the world total volume at 3.9 trillion cubic feet. Exports from Canada to the United States were 17.2% of the total at 1.4 trillion cubic feet. The Netherlands exported 1.3 trillion cubic feet, and Norway exported 911 billion cubic feet.

North America and Western Europe were the only major geographic areas where natural gas production was lower in 1990 than 1980. North American production was down 6.2% during this 10-year period. The decline was due to a 10.8% reduction in U.S. output. Canadian production was up 27.4% over 1980.

Production in Western Europe was down 0.3% from 10 years earlier primarily due to a drop in the Netherland's output. In other major areas production was up: 126.9% in Africa, 131.3% in Asia and Australasia, 51.1% in Latin America, 150.3% in the Middle East, and 74.2% in the USSR and Eastern Europe.

The natural gas share of worldwide total primary energy consumption moved up from 18.2% in 1975 to 20.1% in 1985. It fell slightly to 19.9% in 1986, then moved up to 20% in 1987, 20.2% in 1988, 21.3% in 1989, and 21.6% in 1990. In the OECD and developing countries, natural gas lost some of its market share, dropping from 19.2% in 1975 to 18.9% in 1985 and 18.1% in 1986. This was primarily due to a drop in United States natural gas production and consumption. In 1987 the market share moved up to 18.8%. It remained at 18.8% in 1988 but increased to 19.3% in 1989 and 19.4% in 1990. In the USSR and Eastern Europe, natural gas accounted for 37.8% of energy consumption in 1990. In 1990 total world consumption increased another 2%.

Although there has been no dramatic shift to natural gas, there have been some indications that demand may increase sharply in the future. It is a clean burning fuel that is not as polluting as other fuels and is therefore looked upon favorably by those concerned with the environment. And, concern for the environment is growing throughout the world.

The biggest hurdle to jump if consumption is going to rise is the high cost of transporting natural gas from the areas with large reserves to the industrial consuming areas. Natural gas is most efficiently transported by pipelines, but long pipelines are very expensive. It can be liquefied and shipped by tanker, but this is also extremely expensive. However, LNG trade is growing and could be quite significant in the future.

As with oil, natural gas reserves are distributed disproportionatly, with reserves concentrated in a few countries. The USSR has by far the largest reserves with 1,600 trillion cubic feet, 38% of the world total, as of January 1, 1991. At their present rate of production, they have a 62.2-year supply. Iran has the second largest level of reserves with 600 trillion cubic feet, 14.3% of total world reserves. Together, Iran and the USSR have over 50% of total world reserves. U.S. reserves are only 3.9% of the total world reserves. The U.S. reserves to production ratio indicates only a 9.7-year supply at the 1990 rate of production.

At the present time, worldwide reserves total an estimated 4,208 trillion cubic feet. At the 1990 rate of production, this represents a 60.9-year supply. But a substantial proportion of those reserves are in countries far from the areas of consumption. This will make it very expensive to utilize these reserves.

OUTLOOK

Worldwide supply conditions have changed markedly over the past year. This is reflected in today's oil market where prices have been quite stable for an extended period. Crude oil prices on the world markets have gone through a period of stability that hasn't been experienced since the early 1980s.

The Persian Gulf War resulted in a substantial reduction in worldwide crude oil capacity. This reduction in capacity has enabled OPEC to balance supply and demand in the market at a price level close to the OPEC target.

Stability in the oil market will probably not last for an extended period. It is quite likely that substantial crude oil production capacity will be added to the market in the next few years. The changes in the market caused by the additional crude oil capacity should be favorable to product consumption and increase demand for oil. The additional capacity will put downward pressure on prices if it rises substantially faster than demand. And the lower prices will boost consumption.

The stable current conditions in the market are quite different than the conditions at the end of 1990. The invasion of Kuwait by neighboring Iraq in early August 1990 had a substantial impact on the demand/supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million bbl/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and Kuwait removed close to 4.2 million bbl/d in exports from these two countries. In addition 300,000 bbl/d of production from the Kuwait share of the Neutral Zone was affected by these events also.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion but moved up sharply afterwards. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

One of the more significant actions that was taken during the conflict was the increase in production capacity by Saudi Ara-

bia and several other major OPEC producers. The increases in capacity and production prevented severe shortages from occurring and prevented total chaos in the market. The additional capacity is also partly responsible for the current stability in the market at a price level that encourages consumption.

This stability will not last forever. Even at existing capacity levels there will be some price movement. It is quite likely that prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. The added capacity in Saudi Arabia and elsewhere has alleviated part of the problem. But as long as the Iraq and Kuwait production remains shut in, the crude oil market will be tight, with little contingency production capacity available. Prices will be higher than if this capacity was available to the market.

Politics, the price level, the rate of economic growth, demand for petroleum products, and the level of OPEC capacity and production will all play a role in determining the outlook on the supply side of the worldwide oil industry. OPEC will have one of the greatest influences but there are other factors that also will dictate the supply side of the industry outlook.

The total supply of crude that is made available in the non- OPEC areas will be determined primarily by the price level. But in the non-OPEC areas there are other factors that are now exerting a great deal of influence. The natural decline rate is beginning to take hold in some of the major non-OPEC producing areas. The Alaskan North Slope and some of the North Sea fields are prime examples of fields with peaking production and expectations of long run future decline.

The outlook for worldwide supply was altered dramatically when prices dropped sharply in 1986. The cyclical fluctuation of prices and the repeated weakness in prices over the past several years have reduced investment in production. Both the level of production and the geographic pattern of supply have been altered by the repeated price corrections. Even though crude prices moved up during the past three years, 1987 to 1990, they did not return to the pre-1986 levels. With prices slipping repeatedly, the industry has been caught in an era of frequent periods of lower than anticipated crude prices.

The following scenario is a summary of what is projected for worldwide supply during the forecast period 1991–1996.

Base Scenario — Production from Iraq and Kuwait has not returned to the market. Kuwait's production capacity has been temporarily destroyed. And the U.N. embargo on oil exports from Iraq has remained in place. Offsetting the lost production has been increases in capacity and production in Saudi Arabia and several other major OPEC producers. Taking the above into account, the net loss in worldwide production capacity was an estimated 4.8 million bbl/d. Estimated excess capacity fell 4.3 million bbl/d.

Prices jumped up sharply in 1990 due to a fear of supply shortages, due to the lost capacity coupled with potential additional disruptions from an armed conflict. The average worldwide price of export crude oil jumped 28.2% to $21.35/bbl. The price fell sharply when it became apparent that there would not be supply disruptions or shortages. The increase in capacity from other OPEC countries helped substantially to calm fears of an oil shortage. The estimated average worldwide

export prices of crude oil for 1991 is $17.80/bbl, down 16.6%.

It is projected that substantial production from Iraq and Kuwait will return to the market in 1992. In addition, some of the other OPEC countries will continue to increase production capacity. As a result, worldwide crude oil production capacity will move up 4.6 million bbl/d in 1992. Excess capacity will move up 4 million bbl/d. This additional excess capacity will put downward pressure on prices. The average worldwide price of export crude oil will fall to $17/bbl in 1992.

This will be repeated in 1993 as capacity continues to move up slightly faster than demand and the downward pressure on prices intensifies. The average price of world export crude oil will fall to $16/bbl in 1993.

During the remainder of the forecast period, demand will move up slightly faster than capacity, and the level of excess production capacity will be reduced. As a result prices will move up increasing to $20/bbl in 1996. During the forecast period the average price of world export crude will move up only $2.20/bbl, 12.4% from the 1991 level.

It is expected that OPEC will continue to be a major factor in determining the worldwide prices for crude oil and the worldwide demand for petroleum products. It is also expected that the OPEC countries with the largest reserves will have the most influence in setting OPEC target prices. OPEC's policy will again be to establish a market clearing production level that will result in a targeted price for their exported crude oil.

In the past, OPEC's inability or unwillingness to keep its production in line with the selected quota and product demand was the major reason for the volatility in prices. And price volatility had an impact on product demand. This problem may plague OPEC and the oil market again, but it is expected that there will be more production discipline in the future. However, the excess capacity should help keep prices relatively low. And the lower prices should stimulate product demand.

It is expected that inflation will average about 3%/year during the forecast period. The modest rise in crude oil prices will mean that the real price of crude may even decline. This would be very stimulative to petroleum product demand. The increase in demand is consistent with one of the key objectives of the OPEC countries with large reserves.

The lower oil prices in 1992 and 1993 are expected to stimulate economic growth and petroleum product demand. Therefore total world crude and other hydrocarbon liquid production is expected to move up. Total world production of crude oil and liquids will move up 1.1% in 1992, increasing 730,000 bbl/d to 65.1 million bbl/d. As the rate of economic growth increases so will demand for energy and for oil. Production is projected to increase 2.2% in 1993, moving up 1.45 million bbl/d to 66.55 million bbl/d. Production will move up steadily for the remainder of the forecast period, mainly due to the relatively low level of oil prices. World production over the five year forecast period will move up 9.6% to 70.56 million bbl/d in 1996, an increase of 6.19 million bbl/d. All of the increase will come from increases in OPEC production. OPEC production will increase 27% during the forecast period, moving up to 31.56 million bbl/d in 1996, an increase of 6.71 million bbl/d.

Worldwide non-OPEC production is expected to fall 520,000 bbl/d during the forecast period, dipping to 39 million bbl/d in 1996. The decline will be due to a drop in production from the USSR and Eastern Europe, which is expected to fall 1.26 million bbl/d to 9.5 million bbl/d in 1996. Production from the other non-OPEC countries is projected to move up modestly during the forecast period, increasing 2.6% to 29.5 million bbl/d.

As a result the OPEC share of the worldwide market will move up from 38.6% in 1991 to 44.7% in 1996.

By the end of the forecast period, the excess production capacity will be declining. It will have fallen to about 12.1% of worldwide demand. At that time the price level will be more dependent upon the objectives of Saudi Arabia and the group of OPEC countries with huge reserves. If this group of OPEC countries decides to meet the rising demand by increasing output and capacity, they can maintain control over prices. With their substantial reserves it would appear to be in this group's best interests to keep price increases modest and prevent prices from increasing rapidly. It would appear to be in their long range best interests to keep prices at a level that will stimulate demand and discourage investment in competing oil and energy sources.

The exploration effort is expected to follow crude oil demand throughout the forecast period. The active international rig count (outside the United States and Canada) continued to fall in 1990 dropping to an average of 907 active rigs for the year. As demand for oil moves up during the forecast period, the rig count is projected to increase. The slightly lower crude oil prices in 1992 and 1993 are not expected to stifle drilling activity. The rig count is expected to continue to move up as long as there is not a collapse in crude oil prices. The active rig count is expected to move up 305 to 1,220 in 1996. Including the United States and Canada, the total rig count is projected at 2,650 in 1996, up 33.2%. The strong demand for crude oil and natural gas is expected to boost the level of drilling activity.

Refining capacity in the world is probably close to sufficient to handle the expected increase in demand, but a modest increase is expected as demand moves up. A higher utilization rate is more profitable for the industry so capacity will not move up as fast as demand. Total worldwide refining capacity is expected to move up marginally during the forecast period. Total capacity is expected to increase 0.9% to 76.5 million bbl/d in 1996.

In the industrial countries, refining capacity is still being adjusted to the new level of petroleum product demand that was a result of the earlier price shocks. Refining capacity was reduced to new, lower demand levels. Now as demand moves up in some industrial countries, refining capacity is becoming short. But new environmental considerations make it almost impossible to add substantial new capacity. This may result in new capacity being added in the developing countries to meet worldwide demand increases. There is a possibility that some industrial countries may consider an adequate level of refining capacity as a national security objective. If that proves to be the case, there may be some additional increase in refining capacity during the forecast period. But it is doubtful that there would be a significant additional increase.

Refining profitability is substantially affected by the utilization rate. Refiners strive for a utilization rate of over 80% in order to achieve adequate operating margins. Although capacity will remain relatively constant during the forecast period, crude runs to refineries will move up with demand. Crude runs will increase along with product demand, moving up 9.6% to 65.1 million bbl/d in 1996. As a result, the overall average utilization rate will move up steadily. The utilization rate will increase from 78.4% in 1990 to 85.1% in 1996.

There is not expected to be any major geographical shift in natural gas production during the forecast period. The USSR is expected to continue to develop their vast reserves, and they are expected to continue to supply European energy needs. However, the political and economic upheaval may cause some problems in the early years of the forecast period.

Natural gas resource development is expected to continue to expand during the 1992–1996 period. The area with the largest reserves, the Middle East, is politically unsettled and a long distance from the larger consuming areas. Any increase in reserves or output in this area is not expected to have a major impact on world natural gas markets during the forecast period. However, increased natural gas development for internal consumption in this area would release additional crude for export. That would reduce the upward pressure on prices resulting from increased crude oil demand.

WORLDWIDE SUPPLY

KEYS TO THE FUTURE

1. There will be substantial additions to OPEC and worldwide crude oil capacity in 1992 and 1993. There will be capacity additions by Saudi Arabia and other major OPEC producers. In addition capacity from Iraq and Kuwait will be added to the market. Worldwide production capacity is projected to move up 7 million bbl/d by 1993. Capacity additions will be far greater than the increase in demand, and worldwide excess capacity will move up 4.8 million bbl/d by 1993.

2. The additional excess capacity will make it difficult to balance production with demand. The excess capacity will put downward pressure on prices in 1992 and 1993. The average price of world export crude oil will fall $1.80/bbl to $16.00/bbl in 1993.

3. During the remainder of the forecast period, worldwide production capacity will continue to rise. But demand will move up faster than capacity and the excess capacity will be slightly reduced. Excess capacity will fall from 14.2% of total demand in 1993 to 12.1% in 1996. The increase in demand will enable prices to move up. The average export crude price will increase to $20.00/bbl in 1996.

4. Economic growth and relatively low prices will stimulate demand for petroleum products throughout the forecast period. Worldwide production of crude oil will move up along with demand. World total production will increase 9.6% to 70.56 million bbl/d in 1996.

5. A substantial drop in production in the USSR will result in a decline in non-OPEC production during the forecast period. Output in the USSR and Eastern Europe is projected to fall to 9.1 million bbl/d in 1994 and then move up to 9.5 million bbl/d in 1996. However, production in 1996 will be down 1.26 million bbl/d from 1991. Output from the other non-OPEC countries is projected to move up 740,000 bbl/d to 29.5 million bbl/d in 1996. The net result will be a decline of 520,000 bbl/d in non-OPEC production.

6. OPEC production will move up substantially to fill the gap between the increasing demand for petroleum due to economic growth and the slide in non-OPEC output. OPEC production is projected to move up 27% to 31.56 million bbl/d in 1996, an increase of 6.71 million bbl/d. OPEC share of world production will move up to 44.7% in 1996.

7. It is expected that OPEC will continue to be an effective cartel. OPEC's ability to set a realistic production quota and adhere to it will again play a major role in determine the price level. Control of OPEC will be dominated by the group of OPEC countries with huge reserves. This group will be led by Saudi Arabia. It is expected that OPEC will show some discipline and have periodic success in supporting the desired price level. The price target will be set relatively low to stimulate demand and discourage investment in alternative fuels.

THE OUTLOOK — WORLDWIDE SUPPLY

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
WORLD OIL PRODUCTION									
Total liquids (thousand barrels/day)									
OPEC	24,775	24,850	25,480	28,180	29,570	30,540	31,560	+6,710	+27.0
Non-OPEC and China	28,025	28,760	28,940	29,120	29,300	29,490	29,500	+740	+ 2.6
U.S.S.R. and East Europe	12,075	10,760	10,680	9,200	9,100	9,300	9,500	−1,260	−11.7
Total World	**64,875**	**64,370**	**65,100**	**66,550**	**67,970**	**69,330**	**70,560**	**+6,190**	**+ 9.6**
WORLD REFINING									
(thousand barrels/day)									
Capacity	75,775	75,800	75,850	75,900	75,950	76,000	76,500	+ 700	+ 0.9
Crude runs	59,770	59,390	60,060	61,400	62,700	63,960	65,100	+5,710	+ 9.6
Utilization rate (%)	78.9	78.4	79.2	80.9	82.6	84.2	85.1	+6.7	+ 8.5
WORLD ACTIVE DRILLING RIGS									
(Excluding U.S.S.R., East Europe & China)									
Outside U.S. & Canada	907	915	1,010	1,100	1,160	1,190	1,220	+305	+33.3
Canada	138	135	150	170	190	210	230	+95	+70.4
U.S.	1,010	940	1,000	1,040	1,080	1,150	1,200	+260	+27.7
Total	**2,055**	**1,990**	**2,160**	**2,310**	**2,430**	**2,550**	**2,650**	**+660**	**+33.2**
CRUDE OIL PRICE									
Average world export price ($/barrel)	21.35	17.80	17.00	16.00	17.50	18.50	20.00	+2.20	+12.4

8. Refining capacity will be increased marginally as demand moves up. Crude throughput will move up along with demand. The refinery utilization rate will increase throughout the forecast period.

OUTLOOK 2000 — WORLDWIDE SUPPLY

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
WORLD OIL PRODUCTION									
TOTAL LIQUIDS									
(thousand barrels/day)									
OPEC	24,775	30,540	35,660	+5,765	+5,120	+10,885	+23.3	+16.8	+43.9
Non-OPEC and China	28,025	29,490	28,130	+1,465	−1,360	+ 105	+ 5.2	− 4.6	+ 0.4
U.S.S.R. and East Europe	12,075	9,300	9,770	−2,775	+470	−2,305	−23.0	+5.1	−19.1
Total	**64,875**	**69,330**	**73,560**	**+4,455**	**+4,230**	**+8,685**	**+6.9**	**+6.1**	**+13.4**
WORLD REFINING									
(thousand barrels/day)									
Capacity	75,775	76,000	77,500	+225	+1,500	+1,725	+0.3	+2.0	+2.3
Crude runs	59,770	63,960	67,860	+4,190	+3,900	+8,090	+7.0	+6.1	+13.5
Utilization rate (%)	78.9	84.2	87.6	+5.3	+3.4	+8.7	+6.7	+4.0	+11.0
WORLD ACTIVE DRILLING RIGS									
(Excluding U.S.S.R., East Europe & China)									
Outside U.S. and Canada	907	1,190	1,370	+283	+180	+463	+31.2	+15.1	+51.0
Canada	138	210	240	+72	+30	+102	+52.2	+14.3	+73.9
U.S.	1,010	1,150	1,350	+140	+200	+340	+13.9	+17.4	+33.7
Total	**2,055**	**2,550**	**+2,960**	**+495**	**+410**	**+905**	**+24.1**	**+16.1**	**+44.0**
CRUDE OIL PRICE									
Average world export price ($/barrel)	21.35	18.50	25.00	−2.85	+6.50	+3.65	−13.3	+35.1	+17.1

U.S. OUTLOOK—DEMAND

il plays an extremely important role in the U.S. economy. A large portion of the energy consumed in the United States is derived from petroleum energy. Therefore changes in the worldwide petroleum industry have a substantial impact on the U.S. economy and on the U.S. demand/consumption of petroleum.

In addition, the U.S. economy is quite dependent upon foreign oil. Therefore the outcome

of the war in the Persian Gulf has had an impact on the demand for oil in the United States and also on the growth of U.S. economic activity. The destruction of the Kuwait oil wells and fields and the embargo on oil from Iraq have removed a substantial volume of oil from the world oil market. This was oil that could be used to supply worldwide demand both in the United States and elsewhere.

The removal of this oil from the world market has tightened the market by removing a great deal of the excess capacity. The tight market initially resulted in a substantial increase in the world price of oil and the price of petroleum products in the United States. In 1990 oil prices reached levels that had not been seen since 1985 or earlier. Following the hostilities, prices dropped from the lofty levels associated with a fear of war related shortages. World crude oil prices stabilized at a level that was higher than prior to the conflict.

The unusual thing was that prices did not vary much with the demand swings during the year. The removal of the Iraq-Kuwait capacity removed a lot of the overhanging excess capacity that had plagued OPEC for the last several years. Producing closer to capacity, it was easier for OPEC to set a production target that came close to balancing the market.

With production close to capacity, it would have been possible for OPEC to drive up the price substantially by withholding some production from the market and forcing buyers to bid up the price. Instead, the remaining large OPEC producers, particularly Saudi Arabia, chose to supply the market at a reasonable price level. That appears to be in keeping with their long-term goal of encouraging oil consumption.

The substantially higher prices at the end of 1990 probably did have an impact on U.S. demand for petroleum products. But the United States was already entering an economic recession, and it is hard to determine the demand response to the price hike.

Petroleum demand is relatively inelastic in the short run. But demand is more flexible than it was during the earlier periods when prices moved up rapidly. A great deal of multiple fuel capacity has been built into U.S. industry. And U.S. consumers have had some past experience with discretionary conservation.

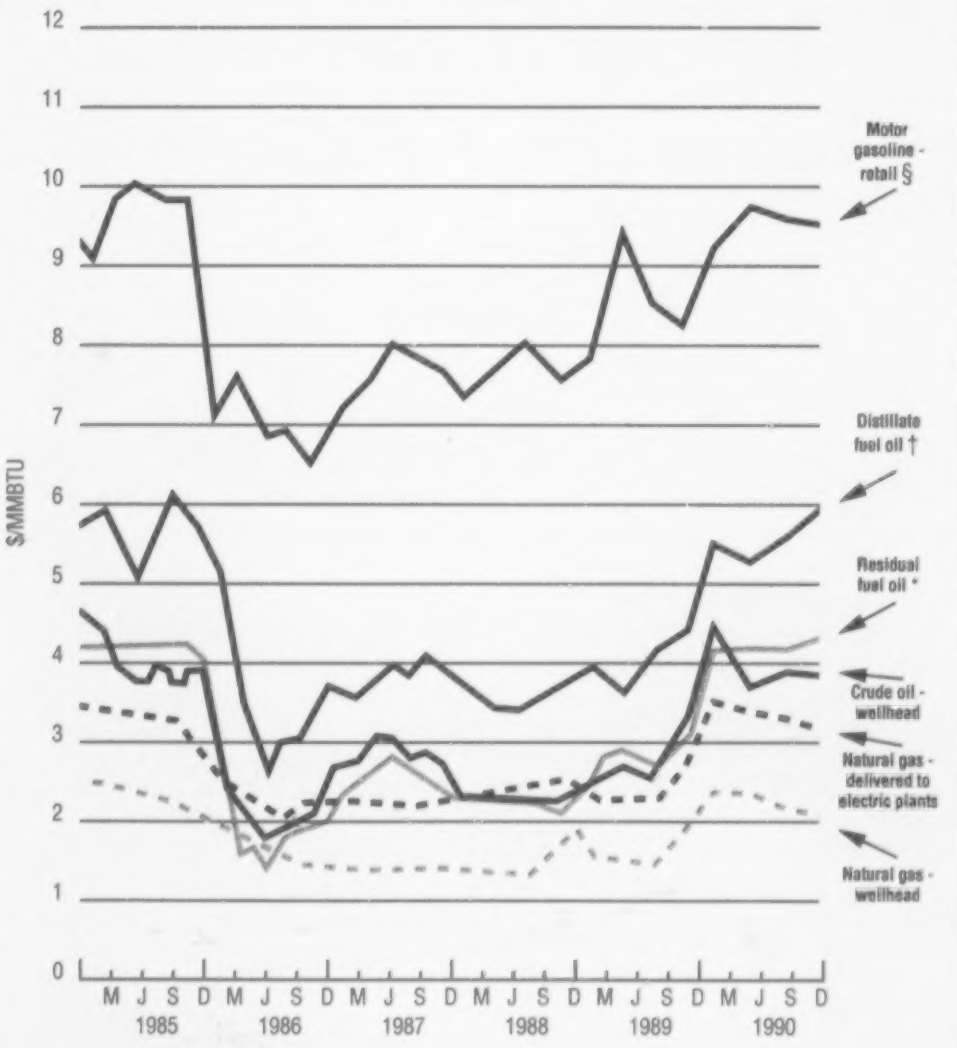
U.S. demand for petroleum products has been on the rise since 1983. The lower level of crude oil and product prices has stimulated consumption. The lower oil prices that have prevailed since 1986 have had a substantial impact on the demand for petroleum products in the United States. The sharp drop in prices in 1986 stimulated demand and brought about the largest year to year increase in consumption of petroleum products since 1977. Although not quite as large, a substantial increase in consumption was posted in 1987 also. The sharp drop in prices in 1988 repeated this cycle, and demand moved up even more than in 1986. Demand continued to climb modestly in 1989. But the economic recession pulled demand down in 1990, and it is expected to fall again in 1991.

Demand has exhibited a close relationship to the price level during the past decade. This has dispelled the theory that oil demand was impervious to the price, or that in economic terms it was totally inelastic. After decades of steadily increasing, oil demand was stopped in its tracks in 1978 and reversed by rapidly escalating oil prices. This was after an almost unbroken string of annual increases in consumption dating back to the 1920s.

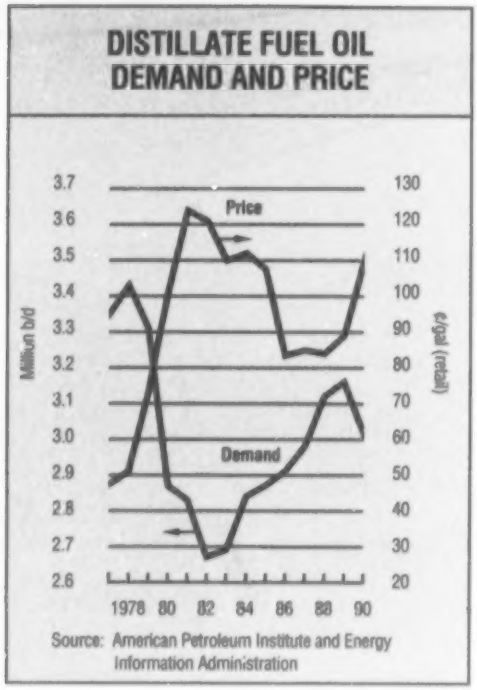
It took some time for the fact to sink in that oil demand does respond to prices. The price changes had to be major in order to make a significant impact on the level of demand. But it did become apparent that a great deal more attention would have to be paid to the relationship between oil demand and price in all future analysis and projections.

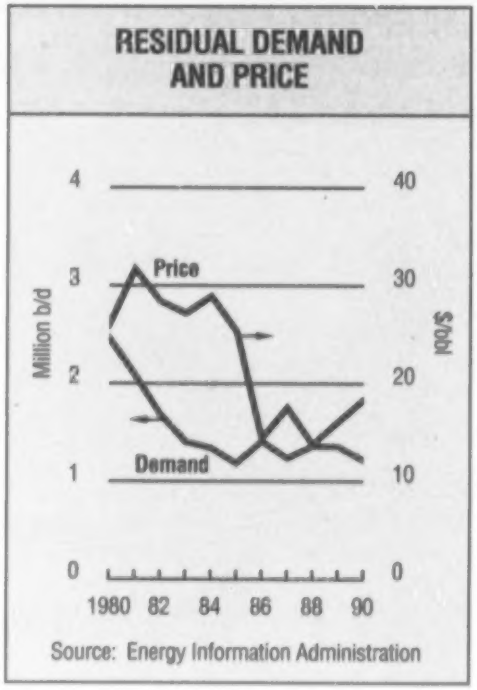
However, it isn't only the price of oil

PETROLEUM PRODUCT AND NATURAL GAS PRICES



* Retail, excluding tax
† Refiners average selling price to resellers & retailers
§ Average all grades, including tax
Source: Energy Information Administration





that has to be considered in any projection, it is also the cost of competing energy sources. Rising energy costs in the 1970s and early 1980s led to conservation and to fuel switching and multiple fuel capabilities. As energy costs rose it became apparent to large energy consumers that the most cost-effective way to meet their energy needs was through the investment in multiple fuel capacity and conservation. With fuel switching capability they could easily switch their consumption to the lowest cost fuel available. This substantially increased the competition between fuels. And as a result the prices of competing fuels tend to closely track each other.

However, substantial differences can arise when there are significant changes in fuel supply markets. As competing fuels adjust prices to obtain a competitive advantage or in reaction to shifts in raw material costs, the swings in demand can be substantial. This happened in 1986 with respect to petroleum products. The precipitous drop in prices enabled petroleum to recapture a portion of some fuel markets it had lost in earlier years.

An additional factor that has an impact on demand for petroleum, or energy in general, is the level of the conservation effort. At lower prices the incentive to invest in conservation capital equipment or fuel switching capital equipment is substantially diminished. And the discretionary conservation exhibited by consumers under higher prices is also greatly reduced. In the years of declining demand, the discretionary conservation of individual consumers had a large impact on the level of consumption of motor gasoline and fuel oils for home heating and cooling.

All of these factors have contributed to the increased consumption of petroleum products during the past several years. Petroleum regained some of its competitive

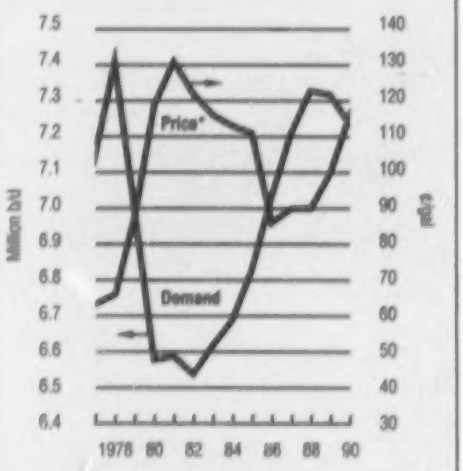
PRICES* OF FOSSIL FUELS USED IN ELECTRIC GENERATION

	Coal	Residual oil	Natural gas	All fossil fuels	Residual oil price — as % of — Coal	Natural gas
			(¢/MMBTU)			
1974	70.9	189.0	48.2	91.4	266.6	392.1
1975	81.4	200.5	75.2	104.4	246.3	266.6
1976	84.8	195.2	103.4	111.9	230.2	188.8
1977	94.7	219.8	129.1	129.7	232.1	170.3
1978	111.6	212.5	142.2	141.1	190.4	149.4
1979	122.4	298.8	174.9	163.9	244.1	170.8
1980	135.1	426.7	219.9	192.8	315.8	194.0
1981	153.2	533.4	280.5	225.6	348.2	190.2
1982	164.7	483.2	337.6	224.9	293.4	143.1
1983	165.6	457.8	347.4	220.6	276.4	131.8
1984	166.4	481.2	360.3	219.1	289.2	133.6
1985	164.8	424.4	344.4	209.4	257.5	123.2
1986	157.9	240.1	235.1	175.0	152.1	102.1
1987	150.6	297.6	224.0	170.6	197.6	133.9
1988	146.6	240.5	226.3	164.3	164.1	106.3
1989	144.5	284.6	235.5	167.5	197.0	120.8
1990	145.4	331.9	232.1	168.8	228.3	143.0

*Delivered price to steam-electric utility plants.

Source: Energy Information Administration

GASOLINE DEMAND AND PRICE



*Major brand regular including state and federal taxes.
Source: American Petroleum Institute and Energy Information Administration

advantages as a fuel, and the conservation incentive was reduced. If prices do not move up significantly, petroleum will probably maintain market share.

The size of the U.S. oil industry in terms of revenue and investment has diminished over the past few years. But it should be remembered that the U.S. economy is still driven to a large extent by the consumption of petroleum and natural gas. These two fuels still provide almost two-thirds of U.S. energy. And their significance will be only marginally reduced over the forecast period. What happens in the oil and gas industry during the next five years is an important part of what happens to the U.S. economy.

REVIEW

ENERGY DEMAND. The level of economic activity and the rate of economic growth are the major determinants of the demand for energy and therefore also for oil and natural gas. The type of economic activity also plays a role in determining the level of energy demand. It has also become evident, particularly in recent years, that the level of energy demand is also closely related to the cost of energy. The degree of energy conservation and degree of efficiency desired is dependent upon the cost of energy relative to other costs of production and goods.

The demand for crude oil, petroleum products, and natural gas in the United States is related to all of the factors mentioned above, i.e., economic activity, overall energy demand, and the cost of energy. Therefore, it is worthwhile to have an understanding of the past trends and relationships among these factors before determining the level of petroleum demand.

Since 1973, the U.S. economy has gone through two recessions. Both followed

FACTORS DETERMINING MOTOR GASOLINE DEMAND

	Total vehicle registrations* (1,000)	Total vehicle miles of travel (Billion)	Car registrations (1,000)	Average age of cars	Fuel consumed per car (Gallons)	Miles traveled per car	Miles per gallon
1970	108,418	1,109.7	89,244	5.8	760	10,272	13.52
1975	132,949	1,327.7	106,706	6.0	716	9,690	13.52
1980	155,796	1,527.3	121,601	6.6	591	9,141	15.46
1982	158,643	1,592.5	123,702	7.2	566	9,428	16.65
1984	166,249	1,720.3	128,158	7.5	536	9,558	17.83
1985	171,654	1,774.2	131,864	7.6	525	9,560	18.20
1986	176,191	1,834.9	135,431	7.6	526	9,606	18.27
1987	179,044	1,921.2	137,324	7.5	514	9,878	19.20
1988	184,397	2,025.6	141,252	7.6	509	10,121	19.87
1989	188,669	2,082.3	144,375	7.6	506	10,382	20.54

*Excludes military vehicles

Source: Motor Vehicle Manufacturers Assoc. Facts & Figures Report 1990, EIA

CRUDE OIL PRICES

	Saudi Light (Jan.1)	U.S. average wellhead	— Refiners' acquisition cost — Domestic	Imported	Composite
	(Dollars per barrel)				
1970	1.35	3.18	3.46	2.96	3.40
1971	1.75	3.39	3.68	3.17	3.60
1972	1.90	3.39	3.67	3.22	3.58
1973	2.10	3.89	4.17	4.08	4.15
1974	10.84	6.87	7.16	12.52	9.07
1975	10.46	7.67	8.39	13.90	10.38
1976	11.51	8.19	8.84	13.48	10.89
1977	12.09	8.57	9.55	14.53	11.96
1978	12.70	9.00	10.61	14.57	12.46
1979	13.34	12.64	14.27	21.67	17.72
1980	26.00	21.59	24.23	33.89	28.07
1981	32.00	31.77	34.33	37.05	35.24
1982	34.00	28.52	31.22	33.55	31.87
1983	34.00	26.19	28.87	29.30	28.99
1984	29.00	25.88	28.53	28.88	28.63
1985	29.00	24.09	26.66	26.99	26.75
1986	28.00	12.51	14.82	14.00	14.55
1987	16.15	15.40	17.76	18.13	17.90
1988	17.52	12.58	14.74	14.56	14.67
1989	13.15	15.86	17.87	18.08	17.97
1990	16.40	20.03	22.60	21.78	22.23
Change 1981-1990	-13.60	-11.74	-11.73	-15.27	-13.01
% change 1981-1990	-42.5%	-37.0%	-34.2%	-41.2%	-36.9%
Change 1970-1990	17.05	16.35	19.14	18.82	18.83
% change 1970-1990	1,263.0%	529.9%	553.2%	635.8%	553.8%

Source: Energy Information Administration

major increases in oil prices and in energy costs in general. One recession was in 1974–1975 when real Gross National Product (GNP), expressed in 1982 dollars, fell 1.8% during two years. The second occurred in 1982, when real GNP fell 2.5%. Between 1978 and 1982 the economy was almost at a stand still with growth of only 1.6%.

The U.S. economy began pulling out of the last recession during 1983. Real GNP moved up 3.6% in 1983. The pace of economic growth accelerated in 1984 with real GNP increasing 6.8%. Since then the economy has been growing at a modest but steady pace, 3.4% in 1985, 2.7% in 1986, 3.4% in 1987, 4.5% in 1988, 2.5% in 1989, and only 0.9% in 1990 as the economy entered a recession. The number of years of growth, from 1982 through 1990, was unprecedented. Economic activity moved up 31.3% during the eight years.

The lock-step relationship between economic growth and energy demand in the United States was broken in 1970. From 1950 through 1970, real GNP increased 100.2%. During the same period, energy consumption increased 97.5%. The amount of energy consumed per real dollar of GNP fell only slightly, from 28,200 BTU per dollar of GNP in 1950 to 27,800 BTU in 1970. Economic growth during that period was being fueled by cheap energy. Growth was primarily in the industrial sector which was relatively energy intensive. With energy quite inexpensive there was little if any incentive for energy conservation. So energy consumption grew as fast as economic output.

This changed markedly in the 1970s when the cost of energy began to increase. And the change continued through the 1980s. From 1970 through 1990, GNP increased 72.1% but energy consumption moved up only 21.4%. During that 20-year period, the growth of energy and GNP moved from a one-to-one relationship to a 0.3 to 1.0 relationship—meaning that energy consumption increased only 3% for every 10% increase in economic activity. This was a dramatic shift from the previous 20 years. The energy consumption has gone up somewhat faster in the past few years. This ratio of growth in energy consumption to growth in GNP was much lower for the period 1970–1984.

Total energy consumption per GNP dollar fell for 20 consecutive years, from 27.8

PETROLEUM PRODUCTS SUPPLIED BY TYPE

	Motor gasoline	% of total	Jet fuel	% of total	Distillate fuel oil	% of total	Residual fuel oil	% of total	Ethane and liquefied gases	% of total	Other products	% of total	Total products	% of total	% change from previous year
	(Million b/d)														
1974	6.54	39.3	0.99	5.9	2.95	17.7	2.64	15.8	1.41	8.5	2.12	12.8	16.65	100.0	-3.8
1975	6.68	40.9	1.00	6.1	2.85	17.5	2.46	15.1	1.33	8.1	2.01	12.3	16.32	100.0	-2.0
1976	6.98	40.0	0.99	5.6	3.13	17.9	2.80	16.0	1.40	8.1	2.16	12.4	17.46	100.0	7.0
1977	7.18	38.9	1.04	5.6	3.35	18.2	3.07	16.7	1.42	7.7	2.37	12.9	18.43	100.0	5.6
1978	7.41	39.3	1.06	5.6	3.43	18.2	3.02	16.0	1.41	7.5	2.52	13.4	18.85	100.0	2.3
1979	7.03	38.0	1.08	5.8	3.31	17.9	2.83	15.3	1.59	8.6	2.67	14.4	18.51	100.0	-1.8
1980	6.58	38.6	1.07	6.3	2.87	16.8	2.51	14.7	1.47	8.6	2.56	15.0	17.06	100.0	-7.8
1981	6.50	41.0	1.01	6.3	2.83	17.6	2.09	13.0	1.47	9.1	2.07	13.0	16.06	100.0	-5.9
1982	6.54	42.7	1.01	6.6	2.67	17.5	1.72	11.2	1.50	9.8	1.86	12.2	15.30	100.0	-4.7
1983	6.62	43.5	1.04	6.8	2.69	17.7	1.42	9.3	1.51	9.9	1.95	12.8	15.23	100.0	-0.5
1984	6.69	42.5	1.18	7.5	2.84	18.1	1.37	8.7	1.57	10.0	2.08	13.2	15.73	100.0	3.3
1985	6.83	43.4	1.22	7.8	2.87	18.2	1.20	7.6	1.60	10.2	2.01	12.8	15.73	100.0	—
1986	7.03	43.2	1.30	8.0	2.91	17.9	1.42	8.7	1.51	9.3	2.11	12.9	16.28	100.0	3.5
1987	7.21	43.3	1.39	8.3	2.98	17.9	1.26	7.6	1.61	9.7	2.22	13.2	16.67	100.0	2.4
1988	7.34	42.5	1.45	8.4	3.12	18.1	1.38	8.0	1.66	9.6	2.33	13.5	17.28	100.0	3.7
1989	7.33	42.4	1.49	8.6	3.16	18.2	1.37	7.9	1.67	9.6	2.31	13.3	17.33	100.0	0.3
1990	7.24	42.6	1.52	8.9	3.02	17.8	1.23	7.2	1.56	9.2	2.42	14.3	16.99	100.0	-2.0

Source: Energy Information Administration

thousand BTU per GNP dollar in 1970 to 19.6 thousand BTU per GNP dollar in 1990. During those 20 years there was a 29.5% improvement in the efficiency of energy consumed.

The rapid increase in the price of energy in the 1970s was a major reason for the improvement in energy efficiency. The rising cost of energy relative to other factors of production provided a cost cutting and profit incentive for minimizing energy requirements.

The oil price hikes of 1973–1974 and 1979–1981 rapidly boosted the cost of petroleum products and the cost of energy in general. This had the effect of providing additional incentive for conservation and accelerated the drop in energy used per dollar of GNP.

Following the 1973–1974 price hike, the economy went into a recession, with real GNP falling in 1974 and 1975. Energy consumption fell from 74,282 trillion BTU in 1973 to 70,546 trillion BTU in 1975, a decline of 5%. Following the 1979–1981 price hike, the economy again went into a recession in 1982. Due to the price induced conservation, energy consumption actually started falling in 1980, and the fall accelerated with the drop in economic activity. Energy consumption fell for four consecutive years, dropping 10.7% from 78,898 trillion BTU in 1979 to 70,497 trillion BTU in 1983.

Since 1981 oil prices have been falling, and other energy costs have dropped also. This has moderated the incentive for conservation. During 1984, real GNP increased 6.8% and energy consumption moved up 5.1%. This is a ratio of 0.75 to 1.0 and is a sharp increase in relative energy consumption. But conservation has not stopped completely. In 1985 GNP increased 3.4% while energy consumption fell 0.2%. In 1986 GNP increased 2.7% while energy consumption only moved up 0.4%. In 1987 GNP was up 3.4% and energy consumption up 3.5%, a return to the 1.0 to 1.0 relationship. In 1988 GNP increased 4.5% and energy consumption moved up 4.4%. In 1989 GNP increased 2.5% and energy consumption moved up 1.4%. In 1990 economic growth slowed to 0.9% and energy consumption moved up a marginal 0.1%. Energy conservation has continued even if the incentive has been muted.

The consumption of petroleum energy per dollar of real GNP also fell after the second oil price hike in 1979. Petroleum energy consumed per dollar of GNP fell from 12.5 thousand BTU in 1977 to 8.6 thousand BTU in 1985. In 1986 it moved up to 8.7 thousand

U.S. ENERGY CONSUMPTION BY SOURCE

	Petroleum	% of total	Natural gas	% of total	Coal	% of total	Nuclear	% of total	Hydro and other	% of total	Total
	(Quadrillion BTU)										
1974	33.455	46.1	21.732	30.0	12.663	17.5	1.272	1.8	3.421	4.6	72.543
1975	32.731	46.4	19.948	28.3	12.663	17.9	1.900	2.7	3.303	4.7	70.545
1976	35.175	47.3	20.345	27.4	13.584	18.3	2.111	2.8	3.147	4.2	74.362
1977	37.122	48.7	19.931	26.1	13.922	18.2	2.702	3.5	2.612	3.5	76.289
1978	37.965	48.6	20.000	25.6	13.765	17.6	3.024	3.9	3.335	4.3	78.089
1979	37.123	47.1	20.666	26.2	15.039	19.1	2.776	3.5	3.293	4.1	78.898
1980	34.202	45.0	20.394	26.9	15.423	20.3	2.739	3.6	3.197	4.2	75.955
1981	31.931	43.2	19.928	26.9	15.907	21.5	3.008	4.1	3.216	4.3	73.990
1982	30.231	42.7	18.505	26.1	15.322	21.6	3.131	4.4	3.659	5.2	70.848
1983	30.054	42.6	17.357	24.6	15.894	22.6	3.203	4.5	4.016	5.7	70.524
1984	31.051	41.9	18.507	25.0	17.070	23.0	3.553	4.8	3.920	5.3	74.101
1985	30.922	41.8	17.834	24.1	17.476	23.7	4.149	5.6	3.562	4.8	73.945
1986	32.196	43.4	16.708	22.5	17.262	23.3	4.471	6.0	3.600	4.8	74.237
1987	32.865	42.8	17.744	23.1	18.008	23.4	4.906	6.4	3.321	4.3	76.844
1988	34.222	42.7	18.552	23.1	18.846	23.5	5.661	7.1	2.914	3.6	80.195
1989	34.211	42.1	19.382	23.8	18.944	23.3	5.677	7.0	3.131	3.8	81.345
1990	33.553	41.2	19.386	23.8	19.094	23.5	6.186	7.6	3.148	3.9	81.367

Source: Energy Information Administration

BTU as oil demand increased at a rate higher than GNP. But it fell again in 1987 to 8.5 thousand BTU per dollar of GNP, and in 1988 it fell to 8.3 thousand BTU per GNP dollar. It remained at that level in 1989. In 1990 the ratio fell again to 8.1 thousand BTU per dollar of real GNP.

A substantial part of the more efficient use of energy has been due to price induced conservation following the rapid and sharp increase in energy costs. But the shift in the profile of the economy has been an important factor also. The United States is moving from a principally industrial economy to a more service and information oriented economy. The service and information types of economic activity are far less energy intensive than industrial activity.

It also should be pointed out that the response to price increases can be spread out over an extended period. It can be rapid in the transportation sector but is generally much slower in the residential/commercial, utility, and industrial sectors. In those latter sectors, adjustment can extend over 5 to 10 or more years. A major portion of this type of demand adjustment is permanent, since it is due to investment in improved capital goods.

In the United States there has been a shift in energy consumption, away from the industrial sector to the residential/commercial and transportation sectors. Consumption in the industrial sector dropped from 31.528 quads in 1973 to 25.756 quads in 1983, a drop of 18.3%. The industrial sector share of total energy consumption dropped from 42.5% to 36.5%. This reflects conservation and more efficient use of energy in the industrial sector, as well as the diminishing importance of the industrial sector in the total economy.

There was a rebound in energy consumption by the industrial sector in 1984. Energy consumption in this sector moved up 7.7% to 27.727 quads, 37.4% of total energy. One of the major reasons for the surge in energy consumption in 1984 was the economic improvement in the more energy intensive industrial sector.

Industrial consumption of energy slipped a bit in 1985 to 27.120 quads, 36.7% of the total energy consumed. It slipped again in 1986 to 26.642 quads, down 2.3%. This was 35.9% of total energy consumed. There was a rebound to 27.87 quads in 1987, up 4.6%. This was 36.3% of total energy consumed. Industrial energy consumed moved up another 4.1% in 1988 to 29.007 quads. This was 36.2% of total energy. It moved up another 1.6% in

1989 to 29.457 quads, 36.2% of total energy. In 1990 the energy consumed by the industrial sector moved up 2.3% to 30.135 quads, 37% of the total. Expectations are that the relative importance of the industrial sector will continue to slide in the future, but the recent upturn in economic activity and industrial output has slowed the slide. Even though the relative share may slide, energy consumption could move up along with growth.

Residential/commercial sector energy consumption increased from 24.14 quads in 1973 to 29.5 quads in 1989, an increase of 22.2%. This sector's share of the total market increased from 32.5% to 36.3%. Energy consumption in this sector slipped to 29.097 quads in 1990, 35.7% of the total. The growth in this sector of the economy has more than offset the improvement in energy efficiency and conservation. Growth is expected to be slow but steady over the forecast period, reflecting the shift to a more service and information oriented economy.

Consumption of energy in the transportation sector has also increased during this period, moving up 19.1% from 18.605 quads in 1973 to 22.16 quads in 1990. The share of total energy consumption increased from 25% to 27.2%. Although there has been continued improvement in vehicle fuel efficiency, the total vehicle fleet has been increasing along with the population. And as gasoline and diesel fuel prices have leveled off during the past few years, there has been less incentive for discretionary conservation. Energy consumption in this sector was up 15.3% during the 7 years, 1983–1990.

There has not only been a shift in the end use of energy, but also a shift in the source of energy. Over the past 15 years, coal and nuclear energy have been increasing their share of the energy market, while petroleum and natural gas have been declining.

The increase in demand for energy in the form of electrical power has been the primary reason for the increase in coal consumption and nuclear power generation. This is due to the changing nature of the economy. This is also part of the shift to a more service-oriented, information-oriented, and automated economy.

Coal energy consumption moved up 34.7% between 1973 and 1985. Coal increased its share of the total energy market from 17.5% to 23.6% in 1985. Coal consumption fell 1.2% in 1986, and coal's market share slipped to 23.3%. Coal rebounded in 1987 moving up 4.3%. The market share moved back up to 23.5%. In 1988 coal energy consumption increased another 4.7%. Share of the market stayed at 23.5%. Coal consumption increased 0.5% in 1989, and the market share dropped to 23.3%. Growth was only 0.8% in 1990, and the coal market share moved up to 23.5%.

In 1986 a sluggish economy, particularly in the industrial sector, had an impact on coal. And coal found itself losing market share to cheap residual fuel oil. That was only a temporary phenomenon, but it did signal the possibility of oil recapturing some of the utility

REFINED PRODUCT PRICES

	Regular motor gasoline pump price (¢/gal)	No. 2 heating oil retail price (¢/gal)	Average landed cost of crude imports ($/bbl)	Refiners' acquisition cost composite ($/bbl)
1977	62.20	47.37	14.36	11.96
1978	62.60	50.80	14.35	12.46
1979	85.70	72.80	21.45	17.72
1980	119.10	100.97	33.67	28.07
1981	131.10	124.66	36.47	35.24
1982	122.20	120.86	33.18	31.87
1983	115.70	110.12	28.93	28.99
1984	112.90	111.97	28.54	28.63
1985	111.50	107.55	26.67	26.75
1986	85.70	83.45	13.49	14.55
1987	89.70	85.15	17.65	17.90
1988	89.90	84.63	14.08	14.67
1989	99.80	88.76	17.68	17.97
1990	114.90	108.74	21.16	22.23

Source: Energy Information Administration
U.S. Dept. of Labor

ECONOMIC GROWTH AND ENERGY CONSUMPTION

	GNP constant 1982 dollars (Billion)	Total energy consumption (Trillion BTU)	Total energy consumption per GNP dollar (Thousand BTU)	Petroleum consumption (Trillion BTU)	Petroleum consumption per GNP dollar (Thousand BTU)
1929	711.8	23,756	33.4	5,521	7.8
1933	501.6	16,900	33.7	4,833	9.6
1940	775.0	23,589	30.4	7,407	9.6
1946	1,077.8	30,494	28.3	10,002	9.3
1950	1,206.6	33,992	28.2	13,489	11.2
1955	1,494.9	39,703	26.6	17,524	11.7
1960	1,665.3	44,569	26.8	20,067	12.1
1965	2,087.6	53,343	25.6	23,242	11.1
1970	2,416.2	67,143	27.8	29,537	12.2
1971	2,484.8	68,348	27.5	30,570	12.3
1972	2,608.5	71,643	27.5	32,966	12.6
1973	2,744.1	74,282	27.1	34,840	12.7
1974	2,729.3	72,543	26.6	33,455	12.3
1975	2,695.0	70,546	26.2	32,731	12.1
1976	2,826.7	74,362	26.3	35,175	12.4
1977	2,958.6	76,289	25.8	37,122	12.5
1978	3,115.2	78,088	25.1	37,965	12.2
1979	3,192.4	78,898	24.7	37,123	11.6
1980	3,187.1	75,952	23.8	34,202	10.7
1981	3,248.8	73,989	22.8	31,931	9.8
1982	3,166.0	70,840	22.4	30,232	9.5
1983	3,279.1	70,497	21.5	30,054	9.2
1984	3,501.4	74,101	21.2	31,051	8.9
1985	3,618.7	73,945	20.4	30,922	8.5
1986	3,717.9	74,237	20.0	32,196	8.7
1987	3,853.7	76,845	19.9	32,865	8.5
1988	4,116.9	80,195	19.5	34,222	8.3
1989	4,117.7	81,345	19.8	34,211	8.3
1990	4,157.3	81,490	19.6	33,640	8.1
1991E	4,140.0	81,210	19.6	33,080	8.0
Percentage change:					
1929-40	8.9	−0.7	−9.0	34.2	23.1
1940-50	55.7	44.1	−7.2	82.1	16.7
1950-70	100.2	97.5	−1.4	119.0	8.9
1970-90	72.1	21.4	−29.5	13.9	−33.6

E - Estimate
Source: Energy Information Administration

and industrial sector if the price was competitive. Multifuel capability makes fuel switching much easier now than in past years.

Energy from nuclear electric power increased 580%, from 0.91 quads in 1973 to 5.186 quads in 1990. The nuclear share of the energy market increased from 1.2% in 1973 to 7.6% in 1990.

Other forms of energy, primarily hydroelectric and geothermal, provided only 3.9% of total energy consumed in 1990. This is down from 4.1% in 1973. Some of this is a temporary weather-related drop in energy output from hydropower. Most of this energy comes from hydropower, where the maximum capacity cannot change easily from year to year and output is dependent upon the weather. Low rain and snowfall reduced hydropower in 1987 through 1989. It began to move back up in 1990.

During the 1973 to 1985 period, the petroleum share of the energy market fell from 46.9% to 41.8%. Energy from petroleum in 1985 was 11.2% lower than 1973, while total energy consumption was down only 0.5%. Lower prices boosted petroleum consumption in 1986, and it increased 4.1%, capturing 43.4% of the energy market. It continued to slip to 42.8% of the market share in 1987, 42.7% in 1988, 42.1% in 1989, and only 41.2% in 1990. Energy demand moved up faster than petroleum demand during this period.

The natural gas share of the total energy market has fluctuated more from year to year than petroleum, but it has also moved down since 1973. Natural gas represented 30.3% of the market in 1973 but was down to 22% in 1987. It moved up slightly to 23.1% in 1988 and 23.8% in 1989 and 1990. Natural gas lost some market share to cheap residual fuel oil in the industrial and utility markets when prices were low in 1986. Natural gas consumption fell to 16.708 quads in 1986, down 25.8% from 1973. It moved back up to 17.744 quads in 1987, 18.552 quads in 1988, 19.382 quads in 1989, and 19.409 quads in 1990.

In 1973 petroleum and natural gas combined accounted for 77.2% of the energy consumed in the United States. This moved down to 65.1% in 1990, a definite downward trend but still almost two-thirds of all energy consumed in the United States.

FUEL COMPETITION. Economic adjustment to the rising cost of energy not only took the form of conservation but also the form of fuel switching. The transition to a greater capacity for fuel switching took time. It was a reaction to the price shift that was spread out over several years. It required a substantial capital investment in most cases and therefore was dependent upon a more lengthy complex economic evaluation—an evaluation which

included the capital investment cost of alternative fuel facilities.

It is evident from the 1986 and 1987 energy statistics that substantial multifuel capability is available in the industrial and utility sectors and, to a lesser extent, in the residential sector. This has enabled some end users to adjust their energy consumption and choose the lowest cost fuel. In many instances in 1986, this turned out to be fuel oil. And it was a surprise to see a rebound in heavy fuel oil consumption.

Although slow to react, natural gas prices and coal prices were forced to adjust to the competition from fuel oil. When fuel oil prices moved back up in 1987, demand for fuel oil dropped and demand for coal and natural gas rebounded. The net result of this substantial multifuel capacity is to keep the BTU cost of competing fuels quite close to each other.

The most competitive interfuel market is in the industrial and utility sectors where residual fuel oil competes directly with both natural gas and coal. And the demand for residual fuel oil is also affected by the expansion of nuclear fuel capacity for generating electricity.

The cost of fuels delivered to steam electric utility plants gives a good picture of how the relative cost of competing fuels has shifted over the past several years. Coal has been, and still is, the cheapest fuel, followed by natural gas and then heavy fuel oil, or resid, as the most expensive. But the price differentials between the fuels has changed over time. And for a short period of time in 1986 there was an unprecedented change; for the first time the cost of resid fell below that of natural gas.

In 1973 the cost of heavy oil for steam electric utility plants was 193.8% of the cost of coal, and heavy oil was 232.2% of the cost of natural gas. These relative prices moved up to heavy oil 348.2% of coal and 190.2% of natural gas in 1981. Natural gas prices also were moving up rapidly during this period. The utility plant average cost for all fossil fuels increased 373.9% from 1973 to its peak in 1981. Since 1981, heavy fuel costs have fallen considerably. The costs of coal and natural gas slowed their rate of increase during the 1981–1984 period and fell slightly in 1985. For the year 1985, the cost of heavy oil for utilities was 257.5% of coal and 123.7% of natural gas. As oil prices plummeted in 1986 the relation-

ENERGY CONSUMPTION—END USER SECTOR

	Residential and commercial	% of total	Industrial	% of total	Transportation	% of total	Total energy consumption
	(Quadrillion BTU)						
1974	23.72	32.7	30.70	42.3	18.12	25.0	72.54
1975	23.90	33.9	28.40	40.3	18.25	25.8	70.55
1976	25.02	33.6	30.23	40.7	19.11	25.7	74.36
1977	25.39	33.3	31.08	40.7	19.82	26.0	76.29
1978	26.09	33.4	31.39	40.2	20.61	26.4	78.09
1979	25.81	32.8	32.82	41.3	20.47	25.9	78.90
1980	25.65	33.8	30.61	40.3	19.70	25.9	75.96
1981	25.24	34.1	29.24	39.5	19.51	26.4	73.99
1982	25.63	36.2	26.14	36.9	19.08	26.9	70.85
1983	25.63	36.3	25.75	36.5	19.14	27.1	70.52
1984	26.50	35.8	27.73	37.4	19.87	26.8	74.10
1985	26.73	36.1	27.12	36.7	20.10	27.2	73.95
1986	26.83	36.1	26.65	35.9	20.76	28.0	74.24
1987	27.62	35.9	27.87	36.3	21.36	27.8	76.85
1988	29.00	36.2	29.01	36.2	22.19	27.7	80.20
1989	29.50	36.3	29.46	36.2	22.38	27.5	81.35
1990	29.11	35.8	30.10	37.0	22.16	27.2	81.37

Source: Energy Information Administration

PETROLEUM PRODUCTS SUPPLIED TO END-USE SECTORS

	Residential and commercial	% of total	Industrial	% of total	Trans.	% of total	Electric utilities	% of total	Total	% of total
	(Million b/d)									
1974	2.04	12.2	4.30	25.8	8.84	53.1	1.48	8.9	16.66	100.0
1975	1.95	11.9	4.04	24.8	8.95	54.8	1.39	8.5	16.33	100.0
1976	2.12	12.1	4.45	25.5	9.37	53.7	1.52	8.7	17.46	100.0
1977	2.14	11.6	4.82	26.2	9.76	52.9	1.71	9.3	18.43	100.0
1978	2.07	11.0	4.87	25.8	10.16	53.9	1.75	9.3	18.85	100.0
1979	1.73	9.3	5.34	28.9	10.01	54.0	1.44	7.8	18.52	100.0
1980	1.52	8.9	4.84	28.4	9.55	56.0	1.15	6.7	17.06	100.0
1981	1.33	8.3	4.27	26.6	9.49	59.1	0.96	6.0	16.05	100.0
1982	1.24	8.1	4.06	26.5	9.31	60.9	0.69	4.5	15.30	100.0
1983	1.29	8.5	3.86	25.3	9.40	61.7	0.68	4.5	15.23	100.0
1984	1.34	8.5	4.11	26.1	9.71	61.8	0.56	3.6	15.72	100.0
1985	1.35	8.6	4.03	25.6	9.87	62.7	0.48	3.1	15.73	100.0
1986	1.35	8.3	4.09	25.1	10.21	62.7	0.64	3.9	16.29	100.0
1987	1.37	8.2	4.26	25.6	10.49	62.9	0.55	3.3	16.67	100.0
1988	1.41	8.2	4.37	25.3	10.82	62.6	0.68	3.9	17.28	100.0
1989	1.40	8.1	4.26	24.6	10.93	63.0	0.74	4.3	17.33	100.0
1990	1.34	7.9	4.27	25.1	10.81	63.6	0.57	3.4	16.99	100.0

Source: Energy Information Administration

EXPORTS OF REFINED PRODUCTS AND CRUDE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
						(1,000 b/d)					
Gasoline	1	2	20	10	6	10	33	35	22	39	55
Distillate	3	5	74	64	51	67	100	66	69	97	109
Residual	34	118	209	185	190	197	147	186	200	215	211
Lubricants	23	19	16	16	15	15	23	23	26	19	20
Coke	137	138	156	195	193	187	238	213	231	233	220
Asphalt and road oil	1	—	1	1	1	—	1	1	1	3	3
LPG	21	42	65	73	48	62	42	38	49	35	40
Other refined products	39	43	38	31	37	39	47	51	62	76	90
Total refined products	**259**	**367**	**579**	**575**	**541**	**577**	**631**	**613**	**660**	**717**	**748**
Crude	287	228	236	164	181	204	154	151	155	142	109
Total exports	**546**	**595**	**815**	**739**	**722**	**781**	**785**	**764**	**815**	**859**	**857**

Source: Energy Information Administration

ship changed rapidly. For the first time, in April 1986, the cost of heavy fuel oil to the utility plants fell below the cost of natural gas. By July 1986 resid prices had fallen 56.6% from the December 1985 price. At that time the resid price was 117.2% of coal and only 85.2% of natural gas.

In the face of this stiff competition from residual fuel oil, both natural gas prices and coal prices fell. Resid prices began to move up again toward the end of 1986, and by November resid had lost its absolute price advantage over natural gas.

The average price of resid delivered to electric utility plants for 1986 was down 43.4%. And for the year the resid price was 152.1% of coal and 102.4% of natural gas. This was a substantial change in the competitive differentials from those in 1981.

During 1986 the cost of coal to electric utilities fell 4.2%, and the cost of natural gas was down 31.7%. The average cost for all fuels fell 16.5%. This is a good example of the intense competition between the fuels.

The 1986 price competition from fuel oil brought the cost of these competing fuels much closer together than they had been in years. During 1987 resid prices moved up along with crude prices. The cost of heavy fuel oil for steam electric utility plants increased 23.9%. But coal and natural gas prices fell as they attempted to recapture this market. The cost of coal fell 4.6% and natural gas slipped 4.7%. For all of 1987, the resid price averaged 197.6% of coal and 132.9% of natural gas. The next year, 1988, was almost a repeat of 1986. The cost of heavy fuel oil fell 19.2%. Coal costs fell 2.7% but natural gas moved up 1%. Heavy fuel oil costs were 164.1% of coal and only 106.3% of natural gas. Fuel oil gained a bit of the market with the lower prices. In 1989 heavy fuel costs moved up faster than the other two fuels. The cost of heavy fuel oil increased 18.3%, natural gas increased 4.1% and coal cost fell 1.4%. Heavy fuel oil costs in 1989 were 197% of coal and 120.8% of natural gas.

The conflict in the Middle East pushed up the price of crude oil and heavy fuel oil in 1990. The cost of heavy fuel oil at electric utilities moved up 16.6%. The cost of coal increased 0.6% and natural gas fell 1.4%. Heavy fuel oil costs moved up to 228.3% of coal and 143% of natural gas. Fuel oil lost considerable market share to coal and natural gas because of the large cost differential.

Compared to the peak in 1981, the average cost of all fossil fuels for electric utilities was down 25.2% in 1990. The cost of heavy oil was down 37.8%, natural gas down 17.3%, and coal down 5.1%. Heavy fuel oil costs peaked in 1981. Coal costs and natural gas costs peaked in 1984.

It is expected that with the extensive

multifuel capacity and the lower price level for crude oil, their relative prices will remain quite close and competitive in the future.

There are a couple of other factors which also may have an impact on this fuel competition. With repeal of the Fuel Use Act, the limitation on the use of natural gas by heavy industry and utilities is eliminated. And environmental concerns over coal use may make it a more costly fuel if substantial investment is required to meet environmental restrictions. This could make both residual fuel oil and natural gas more competitive in that market.

PETROLEUM PRODUCT DEMAND. Except for the current recession years of 1990 and 1991, demand for petroleum products has been moving up in recent years. At the lower price level that has prevailed over the past few years, demand for petroleum products has moved up significantly. Demand increased 555,000 bbl/d in 1986. At the time that was the largest year to year increase in petroleum product demand since 1977. Demand moved up an additional 384,000 bbl/d in 1987, then jumped up 618,000 bbl/d in 1988, but only moved up 42,000 bbl/d in 1989. When the economy slowed in 1990 demand fell 663,000 bbl/d.

Prior to the sharp price hike in the 1979–1981 period, it was felt that petroleum demand was not related to or affected by the price level. But at that time it also was not thought that the price of crude oil could take such gigantic swings. The initial sharp increase in prices took analysts by surprise in the 1970s and early 1980s. And the sharp drop in oil prices in 1986 took the vast majority of analysts by surprise again.

When prices moved up sharply in 1979–1981, petroleum demand reacted and began to fall. Petroleum demand in the United States peaked in 1978 just prior to the second price shock and then fell for 5 consecutive years. This decline was unprecedented in duration. Domestic demand for petroleum products had increased for 31 consecutive years from 1942 to 1973. The only downturn of any duration has been during the great depression, when demand fell for 3 consecutive years between 1929 and 1932.

Following the price rise in 1973–1974, demand for petroleum products fell 5.7% from 17.308 million bbl/d in 1973 to 16.322 million bbl/d in 1975. When prices leveled, demand resumed its increase, rising for 3 more years to peak at 18.847 million bbl/d in 1978. Over that 3-year period, 1975–1978, demand increased another 2.525 million bbl/d, 15.5%.

The second price hike put an end to the steady rise in demand for petroleum products. It had an almost immediate impact on demand. Demand fell 3.616 million bbl/d over the next 5 years to 15.231 million bbl/d in 1983. This was a drop of 19.2% and put demand back at the 1971 level, 12 years earlier. Price induced conservation was the major reason for the decline, but sluggish economic activity also contributed to the drop in petroleum demand.

Demand for petroleum products increased in 1984 after the 5 consecutive years of decline. Lower prices for petroleum products, and substantial economic growth, helped boost demand 3.2% in 1984 to 15.726 million bbl/d. Demand remained at this level in 1985 as economic growth slowed. The substantial drop in prices in 1986 stimulated petroleum product demand that year, and it jumped up 3.5% to 16.281 million bbl/d. Product demand moved up another 2.4% to 16.665 million bbl/d in 1987. This was the highest level of demand since 1980. In 1988 low product prices again stimulated demand, and it moved up 3.7% to 17.283 million bbl/d. The increase slowed in 1989 but did move up 0.2% to

17.325 million bbl/d, the highest level of demand in the 1980s. The start of an economic recession in 1991 lowered demand for energy and for petroleum. As a result the total demand for petroleum products fell 1.9% to 16.986 million bbl/d.

In recent years, the trend in demand for petroleum products has been quite different for the various economic sectors. When prices moved up sharply from 1978–1981, demand fell in all sectors. But when prices started falling, demand reacted differently in the various sectors.

The sharpest decline has been in consumption by electric utilities. Since 1978, electric utilities have moved away from oil to coal and nuclear. Demand dropped from 1.75 million bbl/d to 490,000 bbl/d in 1985, down 72%. The share of total petroleum demand fell from 9.3% to only 3.1%. Competition from nuclear power, coal, and natural gas all reduced demand in this sector. In 1986, for the first time since 1978, consumption of petroleum products by electric utilities moved up. Because of the lower price, consumption jumped up 30.6% to 640,000 bbl/d. This represented 3.9% of total petroleum product consumption. But with the increase in prices in 1987, demand slipped again to 550,000 bbl/d, 3.3% of total consumption. With lower prices again prevailing in 1988, electric utility consumption jumped again to 680,000 bbl/d. It moved up again in 1989 to 740,000 bbl/d even though prices were slightly higher. When the prices jumped in 1990, heavy fuel oil lost share to other fuels with a more competitive price. Electric utility demand fell to 570,000 bbl/d, a decline of 23%. It appears that demand in this sector is extremely sensitive to prices.

Industrial sector demand peaked in 1979 at about 5.34 million bbl/d. It fell to an estimated 3.86 million bbl/d in 1983, down 27.9%. It has moved back up in recent years to 4.37 million bbl/d in 1988, 4.26 million bbl/d in 1989, and 4.27 million bbl/d in 1990.

The industrial sector share of total domestic demand has not changed a great amount. It was 25.9% in 1973 and moved up to 28.9% in 1979. It fell to 25.3% in 1983 but moved back up slightly to 25.4% in 1987, 25.3% in 1988, 24.7% in 1989, and 25.1% in 1990.

Residential and commercial sector demand was trending down from 1973 to 1982, dropping 44.4% from 2.23 million bbl/d to 1.24 million bbl/d in 1982. This sector's share of the total fell from 12.9% to 8.1%. Conversion to natural gas and the use of natural gas for new buildings because of the price advantage was the main reason for the downward shift. Demand in this sector move up in 1987 to 1.37 million bbl/d and 1.41 million bbl/d in 1988. It slipped in 1989 to 1.4 million bbl/d. In 1990 demand fell sharply dropping to 1.34 million bbl/d. Warmer than normal weather, the recession, and conservation due to the price increase led to the downturn. The share of total consumption during this period was 8.2% of total demand in 1987 and 1988, 8.1% in 1989, and 7.9% in 1990.

Transportation sector demand was on the rise from 1982 through 1989. It fell slightly in 1990. The transport share of total demand has been constantly increasing since 1977. Transport demand passed the 1978 peak of 10.16 million bbl/d in 1986. It moved up to a new all time high in 1989 at 10.93 million bbl/d. Demand slipped to 10.81 million bbl/d in 1990.

Transportation demand hit 10.16 million bbl/d in 1978 but then fell 8.4% to 9.31 million bbl/d in 1982. The major reasons for the decline were improved efficiency of motor vehicles and cost consciousness and conservation by drivers.

Transportation demand has been increasing again since 1982 and in 1989 was up 16.5% from that recent low. The transporta-

tion sector's share of total petroleum demand has moved up from 52.9% in 1977 to 62.9% in 1987, 62.6% in 1988, 63% in 1989, and 63.6% in 1990. Lower gasoline prices and the fact that petroleum products do not have major competition from other fuels in the transportation sector have stimulated demand.

A parameter that was underestimated or ignored in some of the older forecasts was the price elasticity of demand for petroleum products—that is, the change in demand relative to a change in price. There is no way to isolate demand for petroleum products and measure only the response due to price change. But the sharp price hikes, particularly in the late 1970s, enable the calculation of a rough estimate of elasticity. Over the past few years, the elasticity of demand for all petroleum products has been approximately 0.1. For every 10% increase in the price, demand fell 1%. This varied from product to product.

Although this would indicate that demand was relatively "inelastic," it does show that, contrary to some past theories of ever increasing petroleum demand, demand would fall if the price increase was too great.

From 1970 to 1981, the composite U.S. refiner acquisition cost of crude oil increased 936%, from $3.40/bbl to $35.24/bbl. This is an increase of $31.74/bbl and an average annual increase of 23%/year. Crude oil prices determine product prices, and therefore product prices also skyrocketed. These massive price increases, far surpassing the overall rate of inflation, had a tremendous impact on investment and consumption decisions and resulted in a reduction in demand for oil products.

The price of crude peaked in 1981 and fell for several years. The average composite U.S. refiner acquisition cost for 1984 was $28.63/bbl. This was a drop of 18.8% from the 1981 average price. Demand rebounded in 1984, increasing 3.2%. This is a roughly 1.7% increase in demand for every 10% decrease in price.

In 1985 the refiner acquisition cost fell an additional 6.5%, but demand remained at the same level as 1984. This would indicate an even lower elasticity of demand, closer to 1% change for every 10% shift in price. In 1986 the refiner composite acquisition cost of crude oil fell another 45.6% to $14.55/bbl. In response demand moved up 3.5%. In 1987 the refiner acquisition cost of crude moved up after declining for five consecutive years. It increased to $17.90/bbl and demand still moved up, increasing 2.4%. In 1988 the refiner acquisition price slipped again, falling 16.2% to $14.67/bbl, and total demand jumped up 3.7%. In 1989 prices rebounded, increasing 22.5% to $17.97/bbl. Petroleum demand was almost constant, increasing only 0.2%. Prices jumped up again in 1990 due to the conflict in the Persian Gulf and increased another 23.7% to $22.23/bbl. Demand in that year fell 1.9%.

Compared to 1981 the refiner cost of crude in 1990 was down 30.2%. Since hitting a low in 1983, demand in 1990 was up 11.5%. Although there was a delayed response, this indicates approximately a 3.8% increase in demand for every 10% drop in price. These are very rough measures, but they do indicate a price elasticity that should be taken into account when projecting demand. However, it will take a longer period to determine if demand elasticity is close to this estimate.

The impact of price on motor gasoline demand has not been as great as for some other petroleum products, but it has been significant. Demand peaked in 1978 at 7.412 million bbl/d and then fell 11.8% to 6.539 million bbl/d in 1982.

The price of gasoline obviously influenced driving behavior, reducing the number of miles driven and changing attitudes about type of vehicles. Drivers cut out a lot of wasteful discretionary driving and also opted to pur-

REAL PRICE OF GASOLINE

	Regular leaded gasoline price (ct/gal)	Real price* (1982-84 $)
1919 *	25.47	147.28
1920	29.83	148.92
1921	26.31	147.03
1922	25.20	150.36
1923	21.97	128.78
1924	20.95	122.56
1925	22.20	126.66
1926	23.38	132.13
1927	21.09	121.48
1928	20.94	122.26
1929	21.42	125.07
1930	19.95	119.51
1931	16.98	111.54
1932	17.93	131.31
1933	17.82	137.57
1934	18.85	140.80
1935	18.84	137.30
1936	19.45	140.38
1937	19.99	139.25
1938	19.51	138.48
1939	18.75	135.00
1940	18.41	131.29
1941	19.23	130.61
1942	20.43	125.40
1943	20.53	118.71
1944	20.59	117.03
1945	20.50	113.92
1946	20.77	106.35
1947	23.11	103.47
1948	25.88	107.52
1949	26.79	112.39
1950	26.76	111.17
1951	27.15	104.53
1952	27.56	103.84
1953	28.69	107.28
1954	29.04	108.05
1955	29.07	108.57
1956	29.93	110.04
1957	30.96	110.18
1958	30.38	105.12
1959	30.49	104.78
1960	31.13	105.17
1961	30.76	102.88
1962	30.64	101.46
1963	30.42	99.41
1964	30.35	97.90
1965	31.15	98.89
1966	32.08	99.01
1967	33.16	99.28
1968	33.71	96.87
1969	34.84	94.93
1970	35.69	91.98
1971	36.43	89.95
1972	36.13	86.44
1973	38.82	87.43
1974	52.41	106.31
1975	57.22	106.36
1976	59.47	104.52
1977	63.07	104.08
1978	65.71	100.78
1979	87.79	120.92
1980	119.10	144.54
1981	131.10	144.22
1982	122.20	126.63
1983	115.70	116.16
1984	112.90	108.66
1985	111.50	103.62
1986	85.70	78.12
1987	89.70	78.89
1988	89.95	76.04
1989	99.80	80.48
1990	114.90	87.91

*Average annual gasoline price deflated by consumer index.

chase more fuel efficient vehicles. A major result of the rapid increase in price was the federal government mandated vehicle fuel efficiency standards. This forced improvement in vehicle fuel efficiency. Gasoline demand fell about 1% for every 10% increase in price during that period of decline. During that period there was also a significant improvement in the fuel efficiency of the vehicle fleet.

As prices have been relatively low during the last few years, some of the conservation impact has diminished and motor gasoline demand has increased. The average pump price for motor gasoline fell below $1/gal for the first time since 1979, declining to 93.1 cts/gal in 1986. When adjusted for inflation the average price of motor gasoline in 1986 was the lowest ever recorded. And motor gasoline demand responded by moving up 3% to the highest level since 1979 at 7.034 million bbl/d. At the time this was only the fourth year on record where gasoline demand exceeded 7 million bbl/d. The other three years had been 1977, 1978, and 1979.

Prices moved up only marginally in 1987 to 95.7 ct/gal. This low price level continued to stimulate demand, which moved up to 7.206 million bbl/d. The average pump price moved up only marginally again in 1988 to 96.3 ct/gal. Demand continued to increase to 7.336 million bbl/d. This was the second highest year in history, surpassed only by the 7.412 million bbl/d in 1978. The average pump price moved up to $1.06/gal in 1989, and demand leveled off at slightly lower than 7.328 million bbl/d. In 1990 the crisis situation in the Persian Gulf pushed up crude oil prices and motor gasoline prices. The average pump price jumped to $1.217/gal, an increase of 14.8%. Demand for motor gasoline in 1990 slipped 1.3% to 7.235 million bbl/d. This was a year of both crisis and recession and is not thought to be representative of the current trend in consumption.

With the real, inflation adjusted, price

at or near historical lows, individual discretionary conservation diminishes substantially. Motor gasoline demand of 7.328 million bbl/d in 1989 was up 12.1% since the recent low in 1982. The average pump price for all types of motor gasoline at $1.06/gal was down 21.7% from the peak of $1.353/gal in 1981. That would represent a 5.6% increase in demand for each 10% decline in price.

The level of demand for motor gasoline is affected by a number of competing factors: vehicle fuel efficiency, average miles driven per vehicle, and total number of vehicles in the fleet.

The total number of registered vehicles has been increasing steadily. It had reached 188.7 million in 1989, up 19.2% from 1981, the year of peak gasoline prices. Car registrations were 144.4 million, up 17.3%. Miles traveled per passenger car in 1989 was 10,382, up 13% from the 9186 in 1981. Miles driven per car was at an all time high of 10,521 in 1972.

These factors are offset by the improved vehicle efficiency and declining fuel consumption per vehicle. The average miles driven per gallon of gas consumed was 20.54 in 1989. This is up 28.9% since 1981 and up 54.4% from the low of 13.3 miles per gallon in 1973.

Highway and rail transport and residential and commercial heating are the major uses for distillate. Demand for distillate fuel oil also peaked in 1978, at 3.432 million bbl/d. It then fell sharply, 22.2%, to 2.671 million bbl/d in 1982. Between 1978 and 1981, the price of home heating oil increased 165.1%, from 38.7 ct/gal to $1.026/gal. This resulted in a shift to natural gas for heating, an increase in personal conservation, and a sharp cut in fuel oil used. During the decline, distillate demand fell about 1.25% for every 10% increase in price.

Distillate prices have been falling since 1981 also. As a result, the trend in distillate demand has been moving up since 1982. Demand moved up 18.2% from 1982 through 1989. Distillate demand moved up 1.6% in 1986 as prices fell sharply. It then moved up another 2.1% in 1987 and 4.9% in 1988 when prices softened again. Demand increased 1.1% in 1989 as prices moved up again. The recession, higher prices, and warm weather all contributed to a drop of 4.3% in distillate demand in 1990.

Highway diesel distillate demand is closely related to the level of economic activity. It has been increasing as the economy has expanded. This trend is expected to continue with diesel consumption moving up along with economic activity.

This increase in distillate demand has been partially offset by a decline in demand for home heating oil. Home heating oil has been losing share in the residential and commercial heating market to natural gas. As oil prices have declined, conversions to natural gas have slowed, but natural gas is still gaining market share. Natural gas or electric home heating are capturing a major share of new construction.

Changes in demand for residual fuel oil has accounted for a large share of the change in total petroleum product demand. Between 1978, the year of peak petroleum demand, and 1985, total petroleum product demand was down 3.121 million bbl/d. Residual fuel oil demand in 1985 was 1.202 million bbl/d down 1.821 million bbl/d from the 1978 level. The drop in resid consumption was 58.3% of the decline in total petroleum consumption. Resid demand in 1985 was down 60.9% from the peak in 1977 of 3.071 million bbl/d.

The shift by electric utilities from residual fuel oil to cheaper fuel sources such as coal, nuclear, and hydro was the major reason for the drop in resid demand. In 1978 almost half of the resid consumed was by the utility sector, 48.3%

or 1,461 million bbl/d. By 1985 utility sector demand had fallen 71% to an estimated 424,000 bbl/d. Industrial demand also was down sharply, falling from 622,000 bbl/d in 1978 to an estimated 182,000 bbl/d in 1985.

The resid demand response to the price increases was a lot greater than for some other products. With more competition from competing fuels, resid demand tends to be more "elastic." Resid demand fell about 3% for every 10% increase in price.

One of the reasons that resid demand fluctuates so greatly is the fuel switching capability of U.S. consumers. It is estimated that there is fuel switching capability in place to reduce fuel oil consumption by 350,000–620,000 bbl/d by switching to other available fuels.

In 1986 demand jumped up 18%, an increase of 216,000 bbl/d. The much lower crude and resid prices enabled resid to recapture a portion of the industrial and utility demand for heavy fuel oil. The increase in resid demand accounted for 36.4% of the total increase in demand in 1986.

Resid demand slipped in 1987, falling to 1.264 million bbl/d, down 10.9%. Higher prices in 1987 decreased its competitive position in the electric utility and industrial sectors. But falling prices again boosted demand for resid in 1988. Demand rebounded, increasing 114,000 bbl/d, 9%, to 1.378 million bbl/d. Electric utility consumption was up 24.5% to 628,000 bbl/d. In 1989 resid demand slipped marginally to 1.37 million bbl/d. Resid prices were up 17.1%. Resid prices jumped again in 1990 and demand fell to 1.229 million bbl/d. Prices moved up 15.3% and demand fell 10.3% in 1990. Electric utility consumption fell to 497,000 bbl/d, down 25%.

The long range demand for resid will depend upon its competitive price compared to natural gas and coal. Projecting toward the end and beyond the forecast period, the fuel source for growing electrical power demand is in doubt. There is little if any additional nuclear power capacity planned beyond the mid 1990s. Environmental concerns over acid rain are growing, and this may put some temporary economic limitations on the growth of coal consumption. This may open up an opportunity for renewed demand for heavy fuel oil to meet electric utility fuel requirements.

Other petroleum products demand also has been moving up during the past few years. Demand for jet fuel has moved up rapidly during the period 1982–1990. Total demand for jet fuel has increased 50.2% to 1.522 million bbl/d in 1990. The increase has been in demand for kerosine jet fuel for commercial aircraft. Deregulation in the airline industry has led to keen competition along with fare slashing. The ability to cut fares was assisted by lower fuel cost. The lower fares stimulated interest in travel by air. The result was a substantial increase in passenger traffic and a jump in jet fuel demand. This trend is expected to continue moving along with the growth in the economy.

Demand for all other products also moved up faster than total demand. This group includes petrochemical feedstocks, lubricants, still gas, waxes, asphalt, coke, and others. Demand is expected to continue to move up. It will be driven by petrochemical demand, asphalt demand, and lubricant demand. Asphalt demand is expected to be high for some time due to the needs to repair and resurface the state and interstate highways.

OUTLOOK

Future events in the U.S. oil industry are closely tied to events in the worldwide industry. Today the impact of any major event anywhere in the world that has an impact on

worldwide crude supply is transferred immediately to the domestic industry via the pricing system and the futures exchanges.

Therefore the events and trends that are taking shape in the worldwide industry will be dictating the trends in the U.S. industry.

The invasion of Kuwait by neighboring Iraq in early August 1990 had a substantial impact on the demand/supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million bbl/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and occupied Kuwait removed close to 4.2 million bbl/d in exports from these two countries. In addition, 300,000 bbl/d of production from the Kuwait share of the Neutral Zone was also affected by these events.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices moved up sharply after the invasion, and the average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

Prices dropped again following the hostilities. Prices on the futures market dropped to around $21/bbl in early 1991. Prices have remained in the range of $20–$22/bbl since then. This is a degree of stability that has not been evident in the crude oil markets for over five years.

The production capacity of Iraq and Kuwait has not been available to the market during this time. The Kuwait production was destroyed when the Iraqi troops ignited the wells before retreating. And the U.N. embargo on exports of crude oil from Iraq has remained in place.

With the reduction of this capacity, OPEC has been more successful at setting a production quota/target that balances supply and demand in the market. However, what may be more significant is that the major OPEC producing countries have boosted their production capacity to a level that has prevented a sharp increase in the price levels. This was a very significant cooperative gesture. With OPEC producing much closer to capacity, it would be possible to set quotas that would force up the price in the short run.

Because of this reaction to the potential worldwide shortage, prices remained elevated for only a short period. This did have an impact on demand, but it was very temporary. The U.S. economy was already in a recession so it is hard to determine if the slump in demand was related to the price level or the economic downturn. Both probably contributed to the downturn in demand in 1990 and 1991.

It was expected that the loss of this oil would tighten the market and place upward pressure on prices as long as the capacity was unavailable. Prices would fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. Therefore as long as that production remains shut in, the crude oil market will be tight, with little contingency production capacity available.

The additional capacity utilized and developed in Saudi Arabia and other major producing countries has prevented markets from being extremely volatile during the peak demand periods. In addition, a number of countries are continuing to expand production capacity or have plans to boost capacity in the future. This expansion of capacity will have a

major impact on the market during the forecast period.

It is expected that excess OPEC production capacity will again be a factor in the market starting in 1992. The additional developed capacity will be coming on stream continuously throughout the forecast period but particularly in the initial years of the forecast. In addition, the capacity of Iraq and Kuwait will be returning to the market. The capacity additions will be greater than the increase in worldwide demand.

OPEC will find it harder to manage the market, and the excess capacity will put downward pressure on prices. As a result, crude oil prices in the world and U.S. markets are projected to fall in 1992 and 1993. During the remainder of the forecast period, prices will move up along with the steady increase in petroleum product demand.

Although many of the events are taking place in the Middle East, they will have an immediate affect on oil prices. And, through the price mechanism, the impact is transferred to the United States.

In the last few years, the combination of lower oil prices, lower petroleum product prices, and increased economic activity gave a boost to U.S. petroleum demand.

What should be kept in mind is that demand for energy and petroleum products is very dependent upon the level of economic activity and will tend to follow the trends in economics growth. But economic growth is also influenced by energy costs. The level of economic activity will still be one of the major factors determining the level of energy demand and petroleum product demand. But the cost of energy is the factors determining the effort given to conservation. And the relative price levels greatly influence the type of energy that will be used to fuel the economic growth. Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelated and interdependent.

There are still a number of major problems that plague the worldwide and U.S. economy. Some of the major problems in the United States are the budget deficit and huge negative international trade balance. And there is a growing threat that a wave of protectionism may sweep over the United States and worldwide industrialized areas and reduce world trade. Any and all of these could slow U.S. economic growth.

The following scenario is a projection of the U.S. demand for petroleum products during the forecast period.

Base Scenario — It is expected that the U.S. economy will start to move out of the recession in the last half of 1991. It is further expected that the growth in U.S. economic activity will pick up in 1992 and 1993, following a decline of 0.4% in 1991. The lower oil prices will contribute to the economic recovery. With lower oil and energy prices in 1992 and 1993, economic growth will rebound. The rate of growth in economic activity is projected at 3% in 1992 and 3.2% in 1993. The economy is expected to continue to grow during the remainder of the forecast period. The rate of economic growth is projected to remain close to 3%/year during the 1994–1996 period. GNP in 1996 is expected to be up 16.4% over the GNP in 1991.

Low energy prices are expected to be a positive stimulus to economic activity throughout the forecast period. Lower energy costs and lower interest rates should boost investment and productivity toward the end of the forecast period. But potential growth will be moderate due to the overhanging burden of huge government, corporate, and personal consumer debt. The economic growth rate could be slowed as attention is diverted from productive activity to debt management.

Looking at the long-term historical relationship of energy consumption to economic growth, it is expected that energy conservation will continue to some degree throughout the forecast period. Therefore the growth in energy demand will track the rate of growth of economic activity but at a slower rate. However, during the years of relatively low energy prices, it is expected that the ratio of energy growth to economic growth will be greater than in the recent past. With low-cost energy there is not as much incentive to invest in conservation. Instead, energy is used more liberally to fuel economic growth.

During the years of low-cost energy, investment in energy conservation will be lower than in past years, but it is still expected to continue to move up. There is now a great deal of concern about the impact of energy consumption on the environment. Therefore there will be a lot of pressure in the United States to improve energy consumption efficiency.

Since growth in energy consumption will follow growth in economic activity, the pattern for the rate of energy growth will be similar to that outlined for economic growth. When oil prices fall in 1992, the rate of growth in economic activity will increase and so will the rate of growth in energy consumption. Total U.S. demand for energy is projected to be up 9% at the end of the forecast period, 1996.

When energy costs decline it is expected that energy consumption will move up at a faster rate relative to GNP than the average since 1970. Energy efficiency improvements will continue, but they will be offset by the increase in energy consumption to support economic growth. With lower-cost energy, there will be less conservation and more energy consumption than with the higher prices.

The trend in the relationship of energy to real GNP will continue down the path of increased energy efficiency. Energy required per dollar of real GNP will fall. Energy required per dollar of GNP will drop from around 19,580 in 1991 down to 18,340 in 1996. This is a further improvement of 6.3% in energy efficiency.

Consumption of energy from petroleum will move up 8.9% during the forecast period. Demand for petroleum has been slowed in 1991 due to the economic slowdown. But energy consumption will move up during the forecast period, boosted by low oil prices. Energy from coal will grow 9.1%, influenced most by demand for electricity. Energy from nuclear power will grow quite slowly during the forecast period, moving up 4.3% to 6.425 quads. No additional nuclear facilities are being constructed. Energy from hydroelectric power and other sources will increase 19.4%. More favorable weather conditions will enable hydropower to move up closer to its capacity. Natural gas will play the role of swing fuel source. As a cleaner fuel and less environmentally damaging, it may displace coal and oil in some instances. Consumption of natural gas energy will move up 8.8% during the forecast period.

There are physical capacity limitations on the growth of nuclear and hydropower. And environmental limitations are being placed on coal consumption due to concerns about clean air and acid rain. This leaves only petroleum and natural gas to fill the additional energy demand. Therefore, later in the forecast period, the level of total energy demand has an additional impact on demand for energy from petroleum and natural gas.

The petroleum share of the energy market will slip only marginally during the forecast period, falling from 40.7% in 1991 to 40.6% in 1996. Natural gas market share will also stay close to the same level, falling from 24% in 1991 to 23.9% in 1996. Coal's share of the market will be 23.7% in 1996, the same

share as 1991. The share from nuclear power will fall from 7.6% in 1991 to 7.3% in 1996. Hydroelectric and other energy sources will capture the share lost by nuclear, moving up from 4.1% in 1991 to 4.5% in 1996.

More energy will be going into electric power production as the economy continues to move toward more electrification. Natural gas could capture some additional market share from coal if there are additional environmental problems associated with the increase in coal consumption.

Petroleum and natural gas in combination will account for 64.5% of total energy needs in 1996. This will be down only slightly from 64.7% in 1991. It is obvious that these energy sources will be extremely important to the U.S. economy for the foreseeable future.

The energy market is expected to become more competitive toward the end of the forecast period. It is expected that the price/cost of competing fuels will continue to converge during the 1991–1996 period.

Petroleum energy demand includes a variety of individual petroleum products. Demand for each of these products is affected differently by the price level, the level of economic activity, and the intensity of competition with other energy. Demand for all major types of petroleum products, including fuel oil, are expected to increase during the forecast period in all of the scenarios.

One of the things that may stimulate demand for petroleum is the growth in electric power consumption in the United States. As the economy grows and shifts to a more information and service oriented economy, demand for electricity will move up. At the lower prices, heavy fuel oil may play the role of swing fuel for electric utilities and demand may increase.

During the five-year forecast period 1992–1996, U.S. petroleum product demand is projected to increase 8.9% to 18.175 million bbl/d in 1996. This is an increase of 1.48 million bbl/d. After prices fall in 1992, demand is expected to move up. Motor gasoline demand is expected to increase 3.1% to 7.38 million bbl/d in 1996. After prices fall in 1992, demand will begin to move up. An increase in the vehicle fleet and an increase in miles driven per vehicle will offset the improvements in fuel efficiency. The rate of increase in fuel efficiency will slow as the older cars are scrapped.

Demand for jet fuel will move up along with economic growth. In 1996 jet fuel consumption will be up 10.4% over the 1991 level at 1.650 million bbl/d. Distillate demand will also increase along with the growth in economic activity, moving up 10% to 3.35 million bbl/d in 1996. The largest increase will be posted by residual fuel oil which is expected to increase 425,000 bbl/d, 36.6%, to 1.585 million bbl/d. Resid demand is expected to move up as a fuel source for generating electrical power. Nuclear power output growth is to slow markedly, and hydropower is limited by existing capacity. Some limitations will be placed on coal consumption because of environmental concerns. Resid and natural gas will be called on to fill the remaining gap.

The combination of lower oil prices and continued economic growth will stimulate total demand for petroleum products during the remainder of the forecast period. However, there are some issues that are preventing a resurgence in oil demand.

A major factor from the consumer side is the uncertainty with respect to prices. Since increased demand of any significant amount must be met by OPEC production, potential consumers are reluctant to commit to capital equipment that requires oil consumption. OPEC is not noted for exhibiting price restraint when the

market conditions are in their favor. However, after the recent crisis, some of the OPEC countries may prove to be a lot more cooperative than in the past.

In any case many major consumers have been preparing for any potential fuel price shock by obtaining multifuel capability. This will tend to keep prices of competing fuels close together, and it will also help to put some downward pressure on prices.

Another factor that is holding down a significant resurgence in oil demand is concerns for the environment. A great deal of pressure is developing for efforts to help alleviate air pollution problems and to start working on the global warming problem. Petroleum products are thought to be one of the major sources of air pollution and a major contributor to global warming. Regulations and programs to resolve these environmental problems may prevent any substantial expansion of petroleum product consumption.

U.S. DEMAND

KEYS TO THE FUTURE

1. It is projected that there will be significant economic expansion throughout the forecast period. The U.S. economy will pull out of the recession, starting in the second half of 1991. The rate of economic growth will move up in 1992 and 1993 when oil and energy prices fall in those two years. Growth will continue throughout the remainder of the forecast but at a slightly slower pace. Inflation will not be a major problem, but the rate will be up from the past few years. Overhanging government deficits and company and consumer debt problems will probably slow the rate of growth from the potential.

2. Both domestic crude oil prices and petroleum producer prices will follow the world oil market prices and fall in 1992. The additional OPEC producing capacity that will be available in the market will put the downward pressure on prices. Prices will move up during the remainder of the forecast period but at a rate slower than the rate of inflation. Relatively low oil and energy prices will continue throughout the remainder of the forecast period.

3. When oil and energy prices fall in 1992, economic growth will be stimulated and energy consumption will be boosted. The combination of continued economic growth and low energy prices will boost energy consumption throughout the remainder of the forecast period. There will be little increased incentive for conservation early in the forecast period. At that time lower energy costs will reduce the incentive for conservation. Energy efficiency will improve but the rate of improvement will be slowed. Technological breakthroughs with respect to more energy efficient equipment and motors could have an impact by the end of the forecast period.

4. Demand for petroleum products will move up at a rate of growth close to the rate of growth of total energy demand. After prices fall, the lower prices will help stimulate consumption of petroleum products throughout the remainder of the forecast period. The level of total demand will be stimulated by the need for heavy fuel oil for electric power generation.

5. When prices fall in 1992, motor gasoline demand will start to move up again. Demand will increase throughout the remainder of the forecast period, but at a very modest rate. Vehicle efficiency will continue to rise as the older cars are replaced. But the increased efficiency will be offset by increased miles driven and an increase in the number of vehicles. The increased population and to some extent increased affluence will boost the vehicle fleet substantially.

6. Continued economic expansion will result in increasing electric power consumption. Growth in nuclear power output will slow during the forecast period. This will necessitate electric utilities turning to heavy fuel oil for some of the future power generation. Therefore, demand for heavy fuel oil will move up during the forecast period.

THE OUTLOOK — U.S. DEMAND

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
ECONOMIC ACTIVITY									
Gross National Product (GNP) (billion 1982 dollars)	4,157	4,140	4,265	4,400	4,540	4,680	4,820	+680	+16.4
ENERGY DEMAND									
(trillion BTU)									
Petroleum	33,553	32,960	33,505	34,130	34,715	35,300	35,890	+2,930	+8.9
Natural gas	19,386	19,430	19,720	20,035	20,370	20,735	21,140	+1,710	+8.8
Coal	19,094	19,180	19,515	19,875	20,220	20,565	20,925	+1,745	+9.1
Nuclear	6,186	6,160	6,265	6,340	6,380	6,395	6,425	+265	+4.3
Hydro and other	3,148	3,350	3,490	3,645	3,795	3,950	4,000	+650	+19.4
Total	**81,367**	**81,080**	**82,495**	**84,025**	**85,480**	**86,945**	**88,380**	**+7,300**	**+9.0**
PETROLEUM DEMAND									
(thousand barrels/day)									
Motor gasoline	7,235	7,160	7,170	7,250	7,310	7,350	7,380	+220	+3.1
Jet fuel	1,522	1,495	1,510	1,545	1,580	1,615	1,650	+155	+10.4
Distillate fuel oil	3,021	2,990	3,080	3,150	3,200	3,300	3,350	+300	+10.0
Residual fuel oil	1,229	1,160	1,180	1,250	1,360	1,440	1,585	+425	+36.6
Ethane and LPG	1,556	1,615	1,670	1,700	1,720	1,740	1,760	+145	+9.0
Other products	2,425	2,275	2,360	2,390	2,410	2,430	2,450	+175	+7.7
Total	**16,988**	**16,695**	**16,970**	**17,285**	**17,580**	**17,875**	**18,175**	**+1,480**	**+8.9**
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	20.03	16.80	16.10	15.20	16.60	17.50	18.90	+2.10	+12.5
West Texas intermediate (posted)	23.17	20.25	19.60	18.80	20.30	21.30	22.80	+2.55	+12.6
MOTOR GASOLINE PUMP PRICE									
Average for all types ($/gallon)	1.22	1.25	1.22	1.20	1.25	1.30	1.35	+0.10	+8.0

7. In the future, environmental concerns will have an increasing and substantial impact on decisions concerning energy consumption. It is presently difficult to quantify the impact, but it will probably lead to higher cost energy. It may have an impact on the type of energy consumed also.

OUTLOOK 2000 — U.S. DEMAND

	1990	1995	2000	Change 1990 to 1995	Change 1995 to 2000	Change 1990 to 2000	% change 1990 to 1995	% change 1995 to 2000	% change 1990 to 2000
ECONOMIC ACTIVITY									
Gross National Product (GNP) (billion 1982 dollars)	4,157	4,680	5,320	+523	+640	+1,163	+12.6	+13.7	+28.0
U.S. REFINING									
(trillion BTU)									
Petroleum	33,553	35,300	37,170	+1,747	+1,870	+3,617	+5.2	+5.3	+10.8
Natural gas	19,386	20,735	23,430	+1,349	+1,695	+3,044	+7.0	+8.2	+15.7
Coal	19,094	20,565	22,050	+1,471	+1,485	+2,956	+7.7	+7.2	+15.5
Nuclear	6,186	6,395	6,550	+209	+155	+364	+3.4	+2.4	+5.9
Hydro and other	3,148	3,950	4,360	+802	+410	+1,212	+25.5	+10.4	+38.5
Total	**81,367**	**86,945**	**92,560**	**+5,578**	**+5,615**	**+11,193**	**+6.9**	**+6.5**	**+13.8**
PETROLEUM DEMAND									
(thousand barrels/day)									
Motor gasoline	7,235	7,350	7,480	+115	+130	+245	+1.6	+1.8	+3.4
Jet fuel	1,522	1,615	1,790	+93	+175	+268	+6.1	+10.8	+17.6
Distillate fuel oil	3,021	3,300	3,530	+279	+230	+509	+9.2	+7.0	+16.8
Residual fuel oil	1,229	1,440	1,610	+211	+170	+381	+17.2	+11.8	+31.0
Ethane and LPG	1,556	1,740	1,850	+184	+110	+294	+11.8	+5.9	+18.9
Other products	2,425	2,430	2,560	+ 5	+130	+135	+0.2	+5.3	+5.6
Total	**16,988**	**17,875**	**18,820**	**+887**	**+945**	**+1,832**	**+5.2**	**+5.3**	**+10.8**
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	20.03	17.50	23.75	−2.53	+6.25	+3.72	−12.6	+35.7	+18.6
West Texas intermediate (posted)	23.17	21.30	28.90	−1.87	+7.60	+5.73	+ −8.1	+35.7	+24.7
MOTOR GASOLINE PUMP PRICE									
Average for all types ($/gallon)	1.22	1.30	1.75	+0.08	+0.45	+0.53	+6.6	+34.6	+43.4

U.S. OUTLOOK—SUPPLY

The outlook for the worldwide crude oil market has changed substantially over the past year. The war in the Persian Gulf temporarily removed a large portion of the excess capacity from world crude oil markets. And because of this some stability has even been restored to the markets. World crude oil prices have remained within a narrow band for the vast majority of the year. And the price level has remained

above the prices just prior to the start of the conflict.

Crude oil markets throughout the world are interrelated. And therefore what has been happening in world oil markets is being transmitted to the U.S. market. U.S. wellhead prices have remained relatively stable over the past year, and prices are above mid-1990 levels. The higher price level and the stability of prices appears to have given some boost to U.S. production. Domestic U.S. output has temporarily arrested the slide that has been going on for a number of years. U.S. crude production has been boosted by the employment of new recovery and drilling technology as well as the completion of maintenance projects in Alaska.

U.S. production during the forecast period will remain very sensitive to worldwide events and particularly to the world price level. Besides being the world's largest consumer of petroleum products, the United States is one of the world's largest producers. It was second behind the USSR in 1990. But despite the huge volume of production, the United States now imports close to 50% of its oil supply. Anything that upsets the world oil market is felt strongly in the United States.

Most of the production in the United States is considered high cost compared to production in many other areas. Therefore the current level of crude oil and natural gas prices have a substantial impact on the domestic supply outlook for the United States. Lower prices, like the industry experienced from 1986 through the first half of 1990, tend to stimulate demand but also tend to depress output, particularly in the higher cost production areas like the United States.

Crude oil production in the United States is not constrained by demand like OPEC output was prior to the conflict in the Persian Gulf. There is no excess capacity problem in the United States. There is no problem finding a market for domestic crude production. In fact, the United States is not self sufficient in crude oil and therefore has been importing crude oil and products for a long time.

The availability of U.S. domestic crude oil is related to the worldwide price of crude oil and the current domestic cost of production. A substantial volume of U.S. production is relatively high-cost production. And high-cost production volume is much more sensitive to any significant change in price. This is not the case for production in some of the prolific low-cost areas such as the Middle East.

The recent high price era, 1980–1985, stimulated U.S. production. At those price levels, U.S. production actually started to move back up after several years of decline. Capital investment flowed into the industry, activity hit record highs, new reserves were found, and output moved higher.

But that trend changed abruptly in 1986 when crude prices plummeted. Particularly in the U.S. lower-48, maintaining the production was dependent upon drilling thousands of new wells. At the lower 1986 price level, much of the drilling activity became uneconomic. In addition to the curtailment of new exploration, many marginal producing wells were considered uneconomic and were shut in. The end result was the start of a slide in U.S. production that has continued through 1989 and 1990. The slide was accelerated in 1989 as Alaskan North Slope production peaked and started down. The slide may be temporarily halted in 1991 but is expected to resume in the following years.

In the past, the supply response to price changes had been relatively slow. But the price decline in 1986 was the only time in recent years that there had been a price drop of that magnitude. And the response this time was a definite and significant decline in U.S. output.

In the long run, U.S. domestic demand

U.S. LIQUIDS PRODUCTION AND RESERVES

	1973	1975	1977	1979	1981	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/79	% change 90/73
	(1,000 b/d)														
Crude & condensate production:															
California	921	883	958	966	1,055	1,109	1,126	1,161	1,114	1,084	1,054	998	961	−0.5	4.3
Kansas	181	162	158	156	180	196	207	207	184	164	161	152	152	−2.6	−16.0
Louisiana	2,278	1,783	1,542	1,355	1,231	1,314	1,408	1,392	1,403	1,320	1,217	1,109	1,076	−20.6	−52.8
New Mexico	276	260	239	217	196	206	217	215	207	198	195	188	184	−15.2	−33.3
North Dakota	55	56	64	84	124	139	144	139	125	113	107	101	101	20.2	83.6
Oklahoma	524	447	428	393	422	435	460	446	409	368	352	322	308	−21.6	−41.2
Texas	3,546	3,348	3,117	2,776	2,589	2,473	2,472	2,435	2,300	2,137	2,062	1,960	1,926	−30.6	−45.7
Wyoming	389	372	374	361	358	324	340	352	332	316	311	295	285	−21.1	−26.7
Others	839	873	901	843	808	778	783	799	739	687	664	614	589	−30.1	−29.8
Total Lower 48	**9,009**	**8,184**	**7,781**	**7,151**	**6,963**	**6,974**	**7,157**	**7,146**	**6,813**	**6,387**	**6,123**	**5,739**	**5,582**	**−21.9**	**−38.0**
Alaska	199	191	464	1,402	1,609	1,714	1,722	1,825	1,867	1,962	2,017	1,874	1,773	26.5	791.0
Total U.S.	**9,208**	**8,375**	**8,245**	**8,553**	**8,572**	**8,688**	**8,879**	**8,971**	**8,680**	**8,349**	**8,140**	**7,613**	**7,355**	**−14.0**	**−20.1**
NGL production:															
Total U.S.	1,738	1,633	1,618	1,584	1,609	1,559	1,630	1,609	1,551	1,595	1,625	1,546	1,559	−1.6	−10.3
Other liquids production:															
Total U.S.	—	—	—	—	50	53	45	55	58	64	53	60	80	—	—
Total liquids production:															
Total U.S.	10,946	10,008	9,863	10,137	10,231	10,300	10,554	10,635	10,289	10,008	9,818	9,219	8,994	−11.3	−17.8
	(Million bbl)														
Total U.S. Reserves															
Crude	35,299	32,682	29,486	27,051	29,426	27,735	28,446	28,416	26,889	27,256	26,825	26,501	26,177	−3.2	−25.8
NGL	6,455	6,268	5,294	5,655	7,068	7,901	7,643	7,944	8,165	8,147	8,238	7,769	7,727	36.6	19.7
Total	**41,754**	**38,950**	**35,480**	**32,706**	**36,494**	**35,636**	**36,089**	**36,360**	**35,054**	**35,403**	**35,063**	**34,270**	**33,904**	**3.7**	**−18.8**
	(Years)														
Reserves/production ratio:															
Crude	10.50	10.69	9.80	8.67	9.40	8.75	8.75	8.68	8.49	8.94	9.00	9.54	9.75		
NGL	10.18	10.52	10.15	9.78	12.04	13.88	12.81	13.53	14.42	13.99	13.85	13.77	13.58		
Total	**10.45**	**10.66**	**9.86**	**8.84**	**9.77**	**9.48**	**9.34**	**9.37**	**9.33**	**9.69**	**9.76**	**10.18**	**10.33**		

Source: American Petroleum Institute; Energy Information Administration

for petroleum products can be met by domestic production and/or imports of crude oil and products. Since U.S. domestic production is unable to support total domestic demand for petroleum products, a substantial and growing volume of imports is required. Imports are the swing supply source and vary with demand. Recently the picture has been rather clear. With increasing demand and declining production, increased imports were required to fill the widening gap between domestic demand and domestic supply.

In the short run, crude and product stocks can help to satisfy demand but only temporarily. Stocks have already been cut close to minimum operating requirements and therefore will not provide a major source of supply during the forecast period. With operating stocks retained at low levels, it is unlikely that refiners will cut inventories. It is more likely that they will retain an adequate level of stocks in case of a supply problem.

REVIEW

PRODUCTION. Crude and condensate production has been sliding in the United States since the early part of 1986. The downward slide has continued from early 1986 through 1990. It now appears that production will be up marginally in 1991, but expectations are that the decline will then continue for the foreseeable future. The precipitous drop in the wellhead price of U.S. crude oil in 1986 was the major reason the slide started. Even though prices rebounded somewhat in 1987, the increase was not sufficient to stop the decrease in U.S. production. Prices slipped again in

CRUDE AND PRODUCT IMPORTS: RELATION TO DEMAND

	1973	1977	1978	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 78/73	% change 90/73
	(1,000 b/d)														
Imports:															
Crude*	3,244	6,594	6,195	5,219	3,323	3,096	3,229	3,083	4,130	4,601	5,056	5,787	5,867	+ 91.0	+ 80.9
Products	3,012	2,193	2,008	1,646	1,625	1,722	2,011	1,866	2,045	2,004	2,295	2,217	2,124	– 33.3	– 29.5
Total	**6,256**	**8,787**	**8,203**	**6,865**	**4,948**	**4,818**	**5,240**	**4,949**	**6,175**	**6,605**	**7,351**	**8,004**	**7,991**	**+31.1**	**+ 27.7**
Domestic demand	17,308	18,431	18,847	17,056	15,296	15,231	15,726	15,726	16,281	16,665	17,283	17,325	16,988	+ 8.9	– 1.8
Dependency ratio: Imports/demand	36.2	47.7	43.5	40.3	32.4	31.6	33.3	31.5	37.9	39.6	42.5	46.2	47.0		

* Excludes imports for Strategic Petroleum Reserve.
Source: Energy Information Administration

1988, and the decline actually began to accelerate. A subsequent price rise in 1989 did little to slow the decline.

U.S. crude and condensate production declined from 9.477 million bbl/d in 1972 to 8.132 million bbl/d in 1976, a drop of 1.345 million bbl/d, or 14.2%. With the development of the Alaskan North Slope, production jumped to 8.707 million bbl/d in 1978. But the decline in lower-48 production pulled the total down again in 1979 as total U.S. production fell to 8.552 million bbl/d.

This downward slide stopped in 1979 and was reversed by the drilling boom of 1980–1982. High domestic crude prices, resulting from the OPEC price increase of 1979–1981, stimulated domestic exploration and development. At these higher prices, production from marginal low volume U.S. wells became profitable. Drilling activity increased markedly because of the increased profitability of smaller discoveries.

Initially the drilling boom arrested the production decline, and U.S. crude output remained fairly constant at 8,597 million bbl/d in 1980 and 8.572 million bbl/d in 1981. But during the next four years, the increase in exploration and drilling actually resulted in an increase in production. The substantial accumulation of new producing wells in the lower-48, coupled with increased Alaskan output, boosted total production to 8.971 million bbl/d in 1985. The higher prices and corresponding increase in drilling activity had helped push U.S. production up 399,000 bbl/d, 4.7%.

The price of crude oil had been the determining factor leading to the increasing production. Prior to that period, the almost unanimous expectations were for declining U.S. production, particularly in the lower-48 states. This rapid increase in prices stimulated domestic exploration and drilling and encouraged the development of previously uneconomic reserves. The drilling and development surge over the 1979–1982 period helped slow the expected decline rate in the lower-48 states. In fact, lower-48 output actually moved up during the 1981–1985 period.

Prior to the drilling boom, the decline in lower-48 production had been somewhat masked by increased Alaskan production. Lower-48 production fell from 9.275 bbl/d in 1972 to 6.953 million bbl/d in 1982, a drop of 2.322 million bbl/d, down 25%.

Effects of the drilling boom began to show up in 1983, as lower-48 output moved up marginally to 6.974 million bbl/d. This was an increase of 21,000 bbl/d—only 0.3%, but a complete reversal of the expected constant rate of decline. Lower-48 production continued to move up in 1984 with output increased to 7.157 million bbl/d. Production in 1985 was sustained at close to this level at 7.146 million bbl/d.

Sliding prices slowed drilling activity from 1983–1985. But the sharp drop in prices in 1986 led to a precipitous drop in drilling activity to the lowest level recorded. Coupled with the shutting in of marginal wells, this led to a drop in lower-48 production of 333,000 bbl/d, 4.7%, to 6.813 million bbl/d for 1986.

Production continued to slide in 1987 even though there was a slight increase in prices. Lower-48 output fell an additional 426,000 bbl/d to 6.387 million bbl/d. Alaskan production increased 95,000 bbl/d in 1987, so total U.S. output was down only 331,000 bbl/d. Lower-48 production continued to drop during 1988. It averaged 6.123 million bbl/d, down another 264,000 bbl/d.

The slide continued in 1989. Lower-48 production fell to 5.739 million bbl/d, down another 384,000 bbl/d, a drop of 6.3%. In 1990 total U.S. output fell to 7.355 million bbl/d. Alaskan production dipped to 1.773 million bbl/d because maintenance work on the pipeline forced a slowdown in throughput during part of the year. Lower-48 production fell another 2.7%, 157,000 bbl/d, to 5.582 million bbl/d. This is the lowest level of lower-48 output since 1950.

Since the recent drilling boom high of 7.157 million bbl/d in 1984, lower-48 output has fallen 1.575 million bbl/d, 22% in six years. This is an average annual decline rate of 4% during this 1984–1990 period.

Until 1989, part of the decline in lower-48 output had been offset by increasing Alaskan production. The Alaskan North Slope was developed in 1977 and 1978. The first full year of North Slope production, 1978, Alaskan output was 1.229 million bbl/d. Production from the North Slope moved up steadily through 1988. Alaskan production in 1988 reached 2.017 million bbl/d. Production in 1988 was up 295,000 bbl/d from the 1984 level and offset 28.5% of the drop in lower-48 output.

But this changed in 1989. Lower prices curtailed some exploration plans in Alaska. Concern over the environmental impact, particularly after the Valdez tanker accident, also slowed production and future development plans. This allowed the natural decline to take over on the North Slope, and Alaskan production fell for the first time in 1989. Output for the year fell 143,000 bbl/d to 1.874 million bbl/d.

In 1990 the average annual production in Alaska fell again, dipping to 1.773 million bbl/d. Part of the decline was due to a slow down in throughput on the pipeline while maintenance work was done on the pipeline and pump stations. It is expected that production will rebound in 1991 because of completion of the maintenance. However, it will probably remain below the 1989 level, indicating some decline in production capacity.

If future development plans are delayed substantially, then Alaskan production could fall more rapidly in the future. This will result in a much faster decline rate for total U.S. output of crude oil.

Also contributing to total liquids output is NGL production. NGL production has not varied greatly during the past several years. Output varies with the relative economics associated with gas liquids products. It is dependent upon the cost of extraction versus the market value of the products. Producers have the flexibility of varying the extraction rate of liquids from gas, dependent upon the economics.

From 1975–1980, NGL output averaged 1.596 million bbl/d. During the next five years, 1981–1985, output averaged 1.591 million bbl/d. Output hit a low of 1.55 million bbl/d in 1982, but was up to 1.63 million bbl/d in 1984 and 1.609 million bbl/d in 1985. As a result of lower prices, NGL production fell sharply in 1986 to 1.551 million bbl/d. Output rebounded in 1987 to 1.595 million bbl/d, and

SPOT MARKET VOLUMES

Year	U.S. Imports (Thousand barrels per day) Total industry imports	Fixed price contract	Spot market
1975	6,056	5,871	185
1976	7,313	7,018	295
1977	8,786	8,346	440
1978	8,201	7,751	450
1979	8,389	7,884	505
1980	6,866	6,386	480
1981	5,740	5,165	575
1982	4,948	3,958	990
1983	4,817	2,887	1,930
1984	5,240	2,358	2,882
1985	4,949	985	3,964
1986	6,176	620	5,556
1987	6,605	660	5,945
1988	7,351	730	6,621
1989	8,005	715	7,290
1990	7,991	7,591	400

Note: Spot market volumes include for 1983 and 1984 contract volumes where the price is directly related to spot market prices and fluctuates with the spot market prices. This might be more aptly labeled "volumes traded on the spot market and at market related prices."

Source: Energy Information Administration and Author's estimates

then moved up to 1.625 million bbl/d in 1988. Output fell to 1.546 million bbl/d in 1989. This was the lowest level of NGL production since 1968. There was a slight improvement in 1990 as NGL output moved up to 1.559 million bbl/d.

Total liquids production, crude and condensate plus NGL, was 10.008 million bbl/d in 1987. That was down 546,000 bbl/d, 5.4% since 1984. Total liquids production for 1988 was 9.818 million bbl/d, down 736,000 bbl/d, 7% since 1984. This was the first time since 1977 that total liquids production had fallen below 10 million bbl/d, and only the third year since 1967. Total liquids output for the United States fell another 599,000 bbl/d, 6.1%, in 1989 to 9.219 million bbl/d. The decline continued in 1990, and total liquids output fell below another level to 8.994 million bbl/d. This was the lowest production level since 1964.

RESERVES. The level of oil reserves and the ratio of proven reserves to current production are key indicators of future production potential.

Total U.S. crude oil reserves fell sharply from 1970 through 1979. Reserves were at a peak in 1970 at 39 billion barrels due to the addition of Prudhoe Bay in Alaska. By 1979 estimated reserves had slipped to 27.1 billion barrels, down 30.6%.

The drilling boom in the United States from 1979–1982 that followed the sharp increase in prices, first slowed the decline in U.S. reserves and then temporarily reversed the long-run decline. Reserves moved back up and were 28.4 billion barrels in 1985.

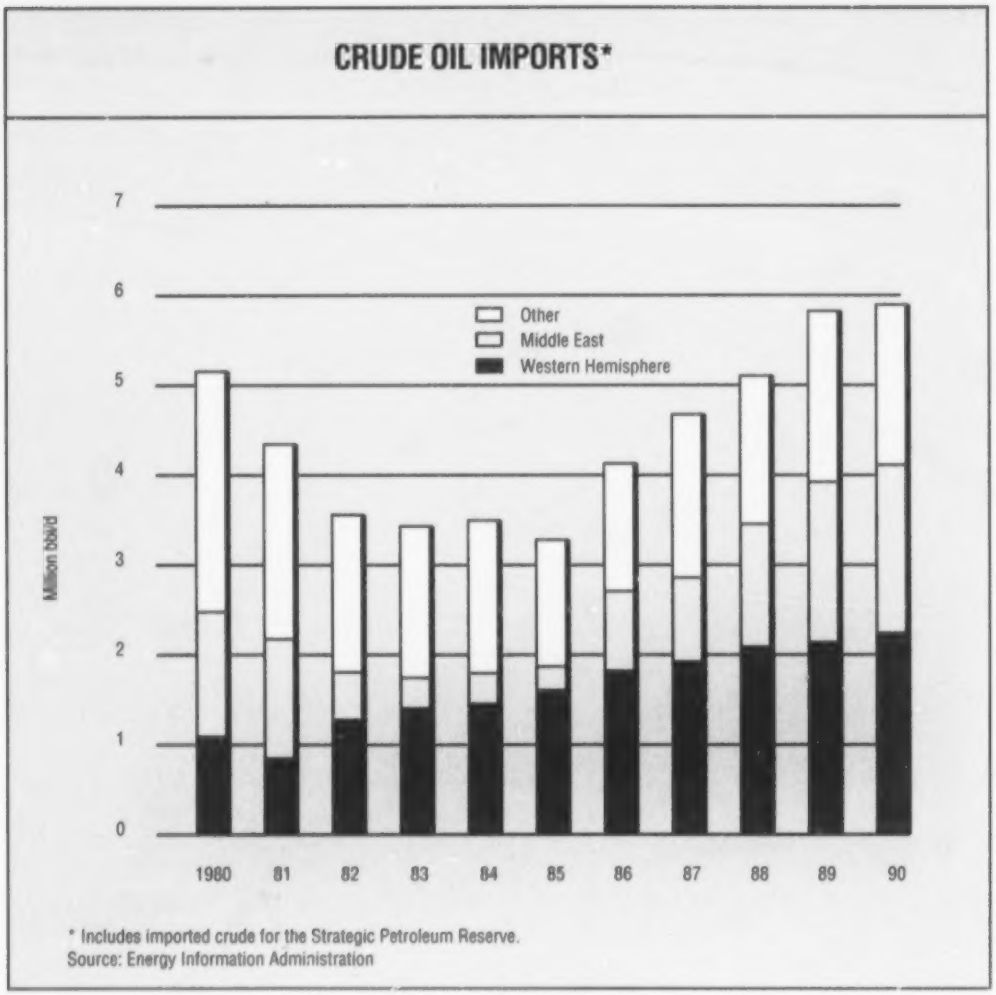
But the sharp drop in prices in 1986 also took its toll on crude reserves. Estimated reserves fell 5.4% to 26.9 billion barrels. This moved back up in 1987 to 27.3 billion barrels. The increase was due to a large revision rather than increased exploration. The reserve estimate fell another 1.6% to 26.825 billion barrels in 1988. The record low level of drilling activity was the major reason for the continued decline.

Estimated U.S. crude oil reserves continued to decline in 1989 and 1990, falling to 26.5 billion barrels in 1989 and 26.3 billion barrels in 1990.

The reserves/production ratio is a good indicator of potential future production. In 1970, the year of peak U.S. reserves, the ratio was 11.09 years. The ratio slipped to 10.68 years in 1975 and then slipped sharply to 8.84 years in 1979, just before the large drilling boom.

The ratio jumped to 9.84 years in 1980 and 9.82 years in 1981 along with the increased drilling activity. The ratio slipped to 9.42 years by 1985. It then slipped in 1986 to 8.5 years, a historic low for this ratio. It moved up slightly in 1987 to 8.9 years and in 1988 to 9 years. Production slipped faster than reserves between 1986 and 1988 causing the increase in the ratio.

The ratio moved up again in 1989 to 9.54 years, and in 1990 to 9.78 years. The ratio moved up as the rate of decline in production exceeded the rate of decline in proven reserves.



However, these low ratios should serve as a signal that action should be taken to stimulate exploration activity. Replacing reserves is essential to the long-term viability of the U.S. domestic industry and to U.S. energy security. Another way to boost reserves may be found in advanced technology to improve the recovery rates from existing known reservoirs. In the future this may prove to be more valuable to the industry than additional exploration work.

IMPORTS. To fill the growing gap between declining U.S. petroleum production and increasing U.S. demand for petroleum products, imports have been rising rapidly in recent years. The role of crude oil and petroleum product imports as an element of U.S. supply is increasing rapidly. U.S. domestic liquids production is not sufficient to meet U.S. demand. Therefore, imports are essential to fill the gap between domestic demand and domestic production.

CRUDE IMPORTS BY COUNTRY OF ORIGIN

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
						(1,000 b/d)					
Eastern Hemisphere:											
Algeria	457	261	90	176	194	84	78	115	58	60	63
Angola	37	45	42	71	85	104	102	180	203	279	236
Egypt	31	33	40	25	10	3	10	54	26	15	25
Gabon	25	35	40	59	57	51	25	35	15	49	64
Libya	549	317	23	—	—	—	—	—	—	—	—
Nigeria	843	611	510	301	207	280	437	529	607	800	784
Other Africa*	62	32	30	48	65	62	89	84	102	83	65
Total Africa	**2,004**	**1,334**	**775**	**680**	**618**	**584**	**741**	**997**	**1,011**	**1,287**	**1,237**
Kuwait	27	—	2	7	24	4	28	70	80	155	79
Oman	24	24	22	34	10	2	8	35	7	18	36
Qatar	22	7	7	—	4	—	12	—	—	2	4
Saudi Arabia	1,254	1,112	530	321	309	132	618	642	902	1,116	1,195
United Arab Emirates	173	77	81	18	90	35	38	56	23	21	9
Other Middle East*	38	6	38	58	23	72	100	182	389	451	535
Total Middle East	**1,538**	**1,226**	**680**	**438**	**460**	**245**	**804**	**985**	**1,401**	**1,762**	**1,858**
Indonesia	315	318	226	315	304	292	297	262	186	158	98
Malaysia	61	33	18	3	—	1	11	12	19	39	40
Other Far East*	1	—	11	7	40	56	80	127	154	137	143
Total Far East	**377**	**351**	**255**	**325**	**344**	**349**	**388**	**401**	**359**	**333**	**281**
Norway	144	114	102	65	112	31	53	70	62	127	96
United Kingdom	174	369	441	365	378	278	317	304	254	160	155
Other Europe*	—	—	—	3	3	1	9	1	5	3	2
Total Europe	**318**	**483**	**543**	**433**	**493**	**310**	**379**	**375**	**321**	**290**	**253**
Other Eastern Hemisphere†	—	37	54	91	120	53	30	—	—	29	—
Total Eastern Hemisphere	**4,237**	**3,431**	**2,307**	**1,967**	**2,035**	**1,541**	**2,342**	**2,758**	**3,091**	**3,701**	**3,630**
Western Hemisphere:											
Brazil	1	14	19	2	—	—	—	—	—	—	—
Ecuador	17	38	22	56	47	56	64	23	33	80	38
Mexico	508	469	645	766	658	715	621	602	674	716	689
Peru	41	30	21	8	1	12	9	1	5	1	2
Trinidad-Tobago	115	102	92	83	87	98	93	75	71	73	76
Venezuela	156	147	155	164	253	305	416	488	439	495	666
Other Latin America*	3	—	—	4	1	—	63	119	112	147	153
Total Latin America	**841**	**800**	**964**	**1,083**	**1,047**	**1,186**	**1,266**	**1,306**	**1,335**	**1,512**	**1,624**
Canada	200	164	214	274	341	468	570	608	681	630	643
Other Western Hemisphere†	—	1	3	5	3	6	—	—	—	—	—
Total Western Hemisphere	**1,041**	**965**	**1,181**	**1,362**	**1,391**	**1,660**	**1,836**	**1,916**	**2,015**	**2,142**	**2,267**
Total Crude Imports	5,278	4,396	3,488	3,329	3,426	3,201	4,178	4,674	5,107	5,843	5,894
Less: SPR Imports	44	256	165	234	197	118	48	73	51	56	27
Crude Imports (ex. SPR)	5,234	4,140	3,323	3,095	3,229	3,083	4,130	4,601	5,056	5,787	5,867
OPEC Imports	3,864	2,922	1,734	1,477	1,512	1,312	2,113	2,400	2,626	3,376	3,514
% OPEC Imports	73.2%	66.5%	49.7%	44.4%	44.1%	41.0%	50.6%	51.4%	52.8%	57.8%	59.6%

*May include data on countries listed specifically but for which no individual data are reported.
†Includes data which could not be broken down by country or continent.
Source: Energy Information Administration

Imports are the swing source of petroleum and vary with the magnitude of the gap between domestic demand and domestic production. Since domestic demand is moving up and domestic production is on the decline, that gap is widening and imports are on the rise. Imports are rapidly reaching a level equal to half of U.S. supply.

It should be noted here that the imports of concern are industry imports. Imports for the Strategic Petroleum Reserve (SPR) are not included in this analysis. SPR imports are more of a national security issue. Until their role in meeting supply needs is better defined, the SPR reserves are not a factor in the demand/supply equation. What is needed is a sound mechanism or policy that clearly defines the way the SPR reserves will be used in an emergency situation. Without that mechanism their use becomes a political issue. An efficient mechanism for their use in balancing the market and dampening price swings would require some provision for immediate response. By the time a political debate is completed, the market will have reacted to the emergency. This was in evidence during the recent crisis in the Persian Gulf. Crude prices moved up immediately when the crisis developed. Releasing crude from the SPR did not really change the direction of the market.

After a long period of rising U.S. imports, total U.S. imports peaked in 1977 at 8.787 million bbl/d. This was during the era of rapidly rising U.S. demand. As demand fell following the huge increase in prices, imports were reduced. Demand fell 3.616 million bbl/d during the period 1978 through 1983. This decline in demand resulted in a drop in imports. Imports fell to 4.818 million bbl/d in 1983, down 3.969 million bbl/d, 45.2%. Imports absorbed the entire drop in U.S. demand. Increased domestic production and stock adjustments backed out an additional 353,000 bbl/d in imports.

As demand began to rise again, total imports moved up in 1984 to 5.24 million bbl/d. But they slipped again in 1985 to 4.949 million bbl/d. Increased domestic production and a drop in crude and product stocks in 1985 enabled a reduction in imports. But by end 1985, stocks had been drawn down close to minimum levels. After that stock draw any increase in demand would have to be met by increased imports.

Imports jumped up sharply in 1986 as demand increased and domestic production fell. Total imports increased 24.8% in 1986 to 6.175 million bbl/d. This was the highest volume of imports since 1980. Imports continued to climb in 1987, filling in the growing gap between slumping U.S. production and increased demand for petroleum products. Imports moved up another 7% to 6.605 million bbl/d. This continued through 1989 as U.S. demand continued to increase and domestic production continued to slide. Total imports moved up another 1.4 million bbl/d to 8.005 million bbl/d in 1989. Imports in 1989 were up 66.2% since 1983. This is an increase of 3.188 million bbl/d. Imports in 1989 moved up over 8 million bbl/d for the first time since 1979. And this was the fourth highest year on record.

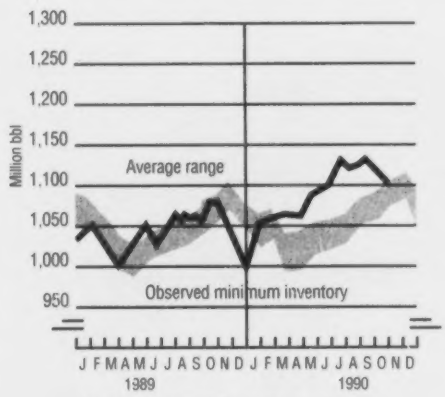
In 1990 there was a miniscule drop in total industry imports which fell 0.2% to 7.99 million bbl/d. Domestic demand fell in 1990 due to the downturn in economic activity, and this led to a leveling of imports of petroleum.

The largest swings have been in imports of crude oil rather than petroleum product imports. Most of the decline which occurred in the years 1977–1983 was in crude oil imports which fell 3.498 million bbl/d, from 6.594 million bbl/d in 1977 to 3.096 million bbl/d in 1983, a drop of 53%. Product imports fell 471,000 bbl/d, 21.5%, from 2.193 million bbl/d to 1.722 million bbl/d in 1983.

Crude imports jumped up in 1984 to

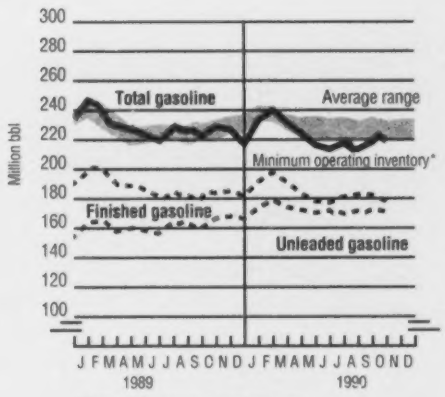
STOCKS

Crude oil & pet. prod.*



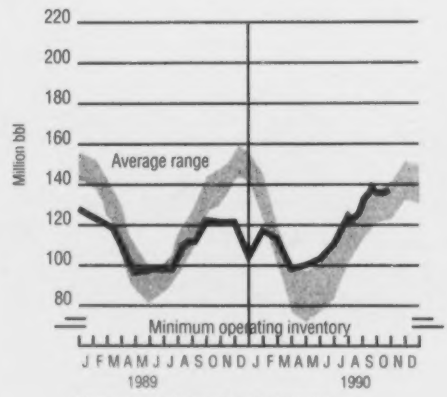
* Excludes stocks for Strategic Petroleum Reserve
Source: Energy Information Administration

Motor gasoline



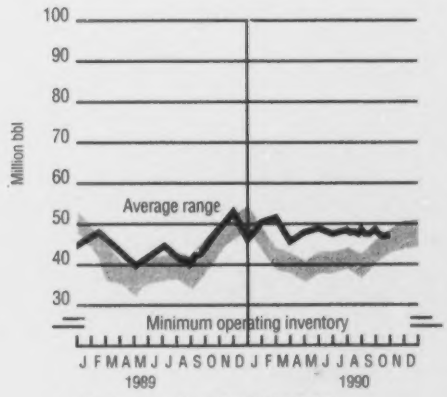
* National Petroleum Council estimate
Source: Energy Information Administration

Distillate fuel oil



Source: Energy Information Administration

Residual fuel oil



Source: Energy Information Administration

U.S. OUTLOOK—SUPPLY

STOCK LEVELS AND DAYS' SUPPLY

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Stocks: (1,000 bbl)												
Crude oil*	339,080	358,166	363,464	349,730	343,850	345,376	320,892	331,224	348,995	330,359	341,291	322,695
Products	911,784	926,262	889,843	786,367	730,698	760,346	704,561	749,723	717,808	707,358	660,271	712,246
Total	**1,250,864**	**1,284,482**	**1,253,307**	**1,136,097**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**	**1,001,562**	**1,034,941**
SPR†	117,687	123,938	230,341	293,827	379,089	450,505	493,316	511,565	540,648	559,515	579,857	585,692
Demand: (1,000 b/d)												
Products supplied	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281	16,665	17,283	17,325	16,988
Days supply:												
Product stocks	49.25	54.31	55.41	51.41	47.97	48.35	44.80	46.05	43.07	40.93	38.11	41.93
Total stocks	**67.57**	**75.31**	**78.04**	**74.27**	**70.55**	**70.31**	**65.21**	**66.39**	**64.02**	**60.04**	**57.81**	**60.92**

*Excluding SPR. †Strategic Petroleum Reserve.

Source: Energy Information Administration

3.229 million bbl/d but then fell again in 1985 to 3.083 million bbl/d. The decline in 1985 was due to increased domestic production and destocking. Crude imports jumped 34% in 1986 to 4.178 million bbl/d. The drop in domestic production coupled with the increase in demand led to the need for more imported crude oil. In addition, refiners took advantage of the low priced crude market to boost crude stocks 3.1%.

Crude imports continued to move up in 1987, reaching 4.601 million bbl/d. In 1988, crude imports jumped up another 9.9% to 5.055 million bbl/d. Imports for 1989 continued this trend increasing another 732,000 bbl/d, up 14.5% to 5.787 million bbl/d. Even though total imports fell in 1990, crude oil imports moved up 1.4% to 5.867 million bbl/d. This also is the highest level since 1979 and is surpassed only by the crude import levels in the 1977–1979 period. The peak year for imports was 1977 at 6.594 million bbl/d.

For the first time in history, in 1989 the volume of crude oil imports surpassed lower-48 crude oil production. Crude imports were 48,000 bbl/d higher than lower-48 output. This gap widened to 285,000 bbl/d in 1990.

The movement in product imports has not been as volatile, but they have followed a similar pattern. Product imports hit bottom in 1981 at 1.599 million bbl/d. They then moved up substantially between 1981 and 1984, increasing 25.8% to 2.011 million bbl/d. Product imports fell to 1.866 in 1985, primarily due to a reduction in product stocks that added 153,000 bbl/d to supply in 1985. Product imports jumped back up again in 1986, increasing to 2.045 million bbl/d, an increase of 179,000 bbl/d. A substantial portion of this increase was an increase in resid imports which moved up 159,000 bbl/d in 1986 in response to the jump in resid demand. U.S. refiners are not set up to optimize resid production so this sudden surge in demand was met by imports.

Even though resid imports fell off a bit in 1987, product imports remained relatively high at 2.004 million bbl/d. Resid imports fell 104,000 bbl/d in 1987. But part of this was made up by increased motor gasoline imports, up 58,000 bbl/d.

Product imports in 1988 jumped up 14.5%, an increase of 291,000 bbl/d, to 2.295 million bbl/d. The increase was in all major product groups. Motor gasoline imports were up 21,000 bbl/d, distillate imports were up 47,000 bbl/d, resid imports were up 79,000 bbl/d and imports of all other various

NEW YORK MERCANTILE EXCHANGE

Total annual contract volumes
Thousand contracts
(Million barrels)

Year	Total oils	Crude oil	Heating oil	Leaded Gasoline*	Unleaded gasoline
1978	50	—	50	—	—
1979	100	—	100	—	—
1980	240	—	240	—	—
1981	1,010	—	950	60	—
1982	1,850	—	1,725	125	—
1983	2,625	350	1,850	425	—
1984	4,589	1,840	2,092	654	3
1985	6,989	3,981	2,208	667	133
1986	12,858	8,314	3,275	630	439
1987	20,931	14,582	4,293	—	2,056
1988	26,495	18,518	4,923	—	3,054
1989	30,263	20,665	5,243	—	4,355
1990	34,985	23,000	6,693	—	5,292

Trading vs. Deliveries
(Thousand barrels)

	Total deliveries	Trading volume	Deliveries as % of trading volume
Crude oil			
1984	66,780	1,494,976	4.5
1985	157,991	3,581,102	4.4
1986	276,127	7,312,164	3.8
1987	434,032	12,986,458	3.3
1988	612,282	18,518,125	3.3
1989	678,942	20,664,640	3.3
1990	719,380	23,000,062	3.1
Heating oil			
1984	28,772	2,117,019	1.4
1985	29,861	2,069,901	1.4
1986	48,216	3,034,981	1.6
1987	79,810	4,021,241	2.0
1988	157,554	4,923,343	3.2
1989	188,123	5,243,235	3.6
1990	263,807	6,692,251	3.9
Unleaded gasoline			
1985	6,684	116,252	5.7
1986	14,068	276,619	5.1
1987	52,645	1,891,088	2.8
1988	127,558	3,053,868	4.2
1989	209,812	4,354,753	4.8
1990	248,297	5,291,561	4.7

* Leaded gasoline trading ended Oct. 1986.
Source: NYMEX (New York Mercantile Exchange)

petroleum products was up 144,000 bbl/d.

Product imports in 1989 slipped a bit to 2.217 million bbl/d. Motor gasoline imports fell 36,000 bbl/d, and resid imports were down 15,000 bbl/d. With slumping demand due to the economic downturn, petroleum product imports slipped again in 1990. Product imports fell 94,000 bbl/d to an average 2.123 million bbl/d for the year.

With excess domestic refining capacity, domestic refiners have more incentive to import crude rather than products. This enabled refiners to increase crude runs and lower unit refining costs. In addition, with the pattern of demand relatively uncertain, crude imports offer refiners additional flexibility. They can change yield patterns as required by demand.

But on the other hand, with worldwide excess refining capacity, imported products are often available at low prices, making product imports economically attractive. Flexibility can be retained by simply importing the product required. As additional export refineries come on stream in the Middle East, and U.S. import requirements rise, product imports may move up in the future. The determining factor will obviously be the cost of crude and processing, relative to the cost of imported products.

However, the problem in the future may be a shortage of domestic refining capacity as demand moves up and refining capacity remains constant.

U.S. import dependency dropped sharply from 1977 to 1983. Prior to that period total imports as a percentage of domestic demand had risen from 29.1% in 1972 to a peak of 47.7% in 1977. With a drop in demand and declining imports, this ratio fell to 31.6% in 1983. The rebound in imports in 1984 pushed it back up to 33.3%. With the drop in imports in 1985, the dependency ratio fell to 31.5%. But then with the surge in imports in 1986, the dependency ratio shot up to 37.9%. This moved up to 39.6% in 1987, 42.5% in 1988, 46.2% in 1989, and 47% in 1990. This ratio is expected to climb during the forecast period and soon be over 50%. The import dependency ratio is a key indicator of U.S. vulnerability to some form of oil supply disruption. Another indicator is the source of oil imports.

As imports declined between 1977 and 1985 and the dependency ratio fell, the source of imports shifted away from some of the more volatile areas. Imports from OPEC countries and the Persian Gulf were reduced

U.S. REFINED PRODUCTS, NATURAL GAS LIQUIDS, AND CRUDE STOCKS

Refined product stocks	1981	1982*	1983	1984	1985	1986	1987	1988	1989	1990
	1,000 bbl									
Gasoline	256,425	247,085	225,042	246,307	225,148	235,490	228,514	230,771	215,670	221,537
Motor†	253,001	244,279	222,434	243,296	222,839	233,057	226,183	228,403	213,441	219,633
Aviation†	3,424	2,806	2,608	3,011	2,309	2,433	2,331	2,368	2,229	1,904
Special naphthas	3,965	3,474	3,153	2,951	3,909	3,759	3,654	3,487	3,005	3,009
Kerosine	11,042	10,792	7,861	11,893	7,502	8,379	8,447	7,284	5,139	5,576
Distillate	191,541	185,579	140,263	161,072	143,673	155,097	134,485	123,517	105,700	132,204
Residual	77,992	68,229	48,504	53,000	50,381	47,437	47,410	44,621	43,838	48,561
Kerosine jet fuel	34,011	32,001	32,346	35,118	33,825	42,677	41,973	37,723	34,471	45,925
Naphtha jet fuel	7,054	7,189	6,265	6,361	6,654	7,072	7,956	6,051	6,380	6,165
Natural gas liquids & LRG	150,170	114,497	116,817	108,446	81,707	109,532	104,119	103,988	88,806	104,038
Unfinished oils	111,348	105,277	108,018	93,506	106,656	94,022	93,185	99,858	106,191	98,669
Other refined products	46,295	44,023	42,429	41,192	45,106	46,258	48,065	50,058	51,071	46,562
Total product stocks	**889,843**	**818,146**	**730,698**	**760,346**	**704,561**	**749,723**	**717,808**	**707,358**	**660,271**	**712,246**
Crude stocks§	363,464	350,044	343,850	345,376	320,892	331,224	348,995	330,359	341,291	322,695
Total stocks	**1,253,307**	**1,168,190**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**	**1,001,562**	**1,034,941**

*Change in Energy Information Administration reporting basis. †Includes blending components. §Excludes stocks for Strategic Petroleum Reserve.

Source: Energy Information Administration

and thus reduced the U.S. vulnerability to an oil supply disruption.

Crude imports from the Persian Gulf countries were reduced substantially, falling from 2.495 million bbl/d in 1977 to 245,000 bbl/d in 1985. Imports from OPEC countries fell 4.331 million bbl/d, from 5.643 million bbl/d in 1977 to only 1.312 million bbl/d in 1985. The share of U.S. crude imports from OPEC countries fell from 85.7% in 1976 to 41% in 1985. This favorable trend away from vulnerability was abruptly reversed in 1986. That year crude imports from the OPEC countries jumped up to 2.113 million bbl/d, an increase of 61.1%. The OPEC share of U.S. crude imports increased to 50.6%. Imports from the Middle East also increased moving up to 804,000 bbl/d in 1986 from only 245,000 bbl/d in 1985. Saudi Arabia became the second leading source of imported crude, providing 618,000 bbl/d. Mexico was the leading source at 621,000 bbl/d.

Crude imports from OPEC moved up to 2.4 million bbl/d in 1987, 51.3% of total crude imports. Saudi Arabia led the way supplying 642,000 bbl/d, followed by Nigeria at 529,000 bbl/d and Venezuela at 488,000 bbl/d.

Crude imports from OPEC jumped up again in 1988. In 1988 OPEC imports accounted for 47.6% of total U.S. imports (including the SPR imports). Saudi Arabia was the leading source in 1988 with 1.064 million bbl/d. This is up from only 168,000 bbl/d in 1985.

In 1989 total imports from OPEC moved up to 4.14 million bbl/d, 51.4% of the total. Saudi Arabia led the way again at 1.224 million bbl/d. This trend continued in 1990. Imports from OPEC moved up to 4.296 million bbl/d. This was 53.6% of the total including SPR imports. Saudi Arabia was again the leading source at 1.339 million bbl/d.

Total crude and product imports from the OPEC countries moved up from 1.83 million bbl/d in 1985 to 4.296 million bbl/d in 1990. This has been an increase of 2.466 million bbl/d, 134.8% in five years.

Non-OPEC country imports to the United States also increased during this period. Total imports from the non-OPEC countries was 3.921 million bbl/d in 1989. This is up 21.1% since 1985, an increase of 684,000 bbl/d. In 1985 non-OPEC imports accounted for 63.9% of total U.S. imports. This was down to 48.6% in 1989. Imports from the non-OPEC countries fell in 1990 to 3.721 million bbl/d. This was 46.4% of the total imports.

AVERAGE ANNUAL PRICE OF CRUDE OIL

Year	U.S. average wellhead price		Saudi Arabian light crude	
	Current dollars	Constant 1982 dollars	Current dollars	Constant 1982 dollars
1950	2.51	9.19	—	—
1951	2.53	8.32	1.75	5.76
1952	2.53	8.55	1.75	5.91
1953	2.68	9.18	1.97	6.75
1954	2.78	9.49	1.97	6.72
1955	2.77	9.45	1.97	6.72
1956	2.79	9.21	1.97	6.50
1957	3.09	9.90	2.08	6.67
1958	3.01	9.53	2.08	6.58
1959	2.90	9.15	1.90	5.99
1960	2.88	9.09	1.80	5.68
1961	2.89	9.15	1.80	5.70
1962	2.90	9.15	1.80	5.68
1963	2.89	9.15	1.80	5.70
1964	2.88	9.11	1.80	5.70
1965	2.86	8.85	1.80	5.57
1966	2.88	8.65	1.80	5.41
1967	2.92	8.74	1.80	5.39
1968	2.94	8.60	1.80	5.26
1969	3.09	8.68	1.80	5.06
1970	3.18	8.62	1.80	4.88
1971	3.39	8.90	2.29	6.01
1972	3.39	8.52	2.48	6.23
1973	3.89	8.64	5.04	11.20
1974	6.87	12.84	11.25	21.03
1975	7.67	13.13	12.38	21.20
1976	8.19	13.40	11.51	18.84
1977	8.57	13.20	12.70	19.57
1978	9.00	12.88	12.70	18.17
1979	12.64	16.06	24.00	30.50
1980	21.59	24.04	32.00	35.63
1981	31.77	32.42	34.00	34.69
1982	28.52	28.52	34.00	34.00
1983	26.19	25.85	29.00	28.63
1984	25.88	24.96	29.00	27.97
1985	24.09	23.34	28.00	27.13
1986	12.51	12.49	15.05	15.02
1987	15.40	14.98	17.53	17.05
1988	12.58	11.77	13.71	12.83
1989	15.86	14.13	16.18	14.42
1990	20.03	17.22	20.81	17.89
1991E	16.80	14.41	17.50	15.01

Note: Prices for Saudi Arabian light crude are official government posted prices 1950–1985; average selling price 1986–1990.

Not only is the United States becoming more dependent on imported oil, but it is also becoming more dependent on OPEC oil.

STOCKS. Crude and product stocks do not have a major impact on the long-run demand and supply situation. However, in the short run, stock swings can play a major role in determining the level of supply, the level of imports, and most significantly the short-run price of crude and products. Stocks can be another source of crude oil and petroleum products. And when on the rise, they also can be an element of demand as refiners build supplies for the future.

Total crude and product stocks, excluding stocks for the Strategic Petroleum Reserve (SPR), fell 210 million bbl from year end 1980 to year end 1983. This added an average 192,000 bbl/d to available supply over that three-year period. Stocks went up marginally, 30 million bbl, in 1984 as demand increased, but were reduced again in 1985 as refiners cut costs. Stocks fell an additional 80 million bbl, and at year end 1985 were down 259 million barrels from year end 1980. This had added 142,000 bbl/d to supply over these five years.

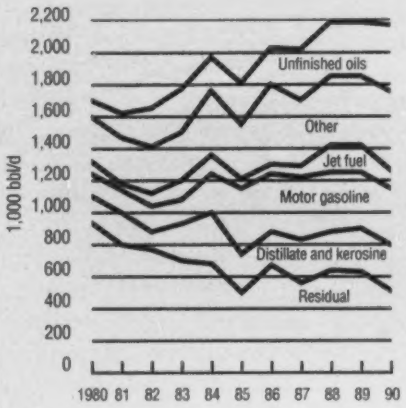
Stocks moved up again in 1986, increasing 55 million barrels. This actually added approximately 150,000 bbl/d to demand in 1986. But then stocks were drawn down again in 1987, falling 15 million barrels. This added about 41,000 bbl/d to supply in 1987. In 1988 companies reduced total stocks 29 million barrels, adding 79,000 bbl/d to supply. And in 1989 industry stocks were lowered another 36 million barrels, adding 99,000 bbl/d to supply demand.

In 1990 the procedure was reversed. Stocks were increased 34 million barrels to a total of 1,035 million barrels. This increased the need for imports to build the inventories.

In the past, stocks were built up substantially at certain times of the year to meet seasonal swings in demand. In addition, the industry was willing to hold stocks as a buffer against an unexpected surge in demand or a potential supply disruption. When demand started falling in 1979, stocks were retained at a relatively high level because the duration and extent of the decline was unknown.

The operating philosophy changed as stocks piled up and carrying costs soared. The high inflation rates of the early 1980s made it quite expensive to maintain excess unneeded stocks. To cut costs, a concentrated effort was made to reduce stocks to the minimum level that was operationally feasible. Stocks were

REFINED PRODUCT IMPORTS



REFINED PRODUCT IMPORTS

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	1,000 bbl/d									
Gasoline	157	197	247	299	381	328	384	405	369	342
Kerosine	7	13	11	12	8	13	17	16	7	5
Jet fuel-kerosine	31	23	29	48	30	48	64	87	102	100
Jet fuel-naptha	7	5	1	14	9	9	3	3	3	8
Distillate	173	93	174	272	200	247	255	302	306	278
Residual	800	776	699	681	510	669	565	644	629	504
Unfinished oils	112	174	284	231	318	250	299	360	348	413
Other*	312	344	327	454	410	483	417	479	454	474
Total U.S.	1,559	1,625	1,722	2,011	1,866	2,045	2,004	2,296	2,218	2,124

* Includes plant condensate
Source: Energy Information Administration

slashed, and the general operating philosophy of refiners appears to be permanently changed to one of maintaining stock levels close to the minimum operating level.

The build up in stocks in 1986 was mainly a result of the extremely low prices and the net-back pricing schemes that surfaced at that time. Refiners built up stocks to take advantage of the low crude costs. And many of the net-back pricing arrangements made it highly profitable for refiners to purchase and store large quantities of crude. They were virtually assured of a profit on all product transactions connected to the crude purchased.

But that stock buildup was only temporary. Net-back pricing schemes were abandoned by the producing countries since they appeared to be driving down the price of crude oil at the wellhead. A substantial portion of the stock buildup in 1986 was worked off by mid-1987, and refiners were back to operating at minimum stock levels in order to reduce costs.

A good measure of the adequacy of stocks to meet demand is the number of days of supply they represent. Total industry stocks represented 58 days supply in 1973. This increased to 78 days at year end 1981. After the sharp reduction in stocks, there was some concern about the adequacy of stock levels, but stocks at year end 1984 still represented over 70 days supply at the reduced demand level of 1984. The additional sharp cut in stocks in 1985 dropped the days supply to 65.2 days at year end 1985. This was the lowest level since 1974. This moved up to 64 days in 1987 but then dipped to 60 days supply at year end 1988. It fell sharply to 57.8 days at year end 1989. This placed stocks at close to minimum levels, and refiners built stocks in 1990. The days of supply moved up to 60.9 at year end 1990. Refiners try to maintain a comfortable balance between changing demand and the stock level to avoid any potential supply disruptions.

Most of the reduction in stocks has been product stocks. From year end 1981 to year end 1990 total industry stocks have been reduced 219 million barrels. Crude stocks have

been reduced only 40 million barrels while product stocks have fallen 179 million barrels. Refiners find it advantageous to maintain higher crude stocks. With excess refining capacity available, refiners can run crude to meet unexpected swings in product demand.

But stocks appear to be close to a minimum level if supply disruptions are to be avoided. With demand expected to rise in the future, it does not appear that stocks will be reduced in the future.

Crude oil stocks in the SPR surpassed industry crude oil stocks in July 1983. At year end 1990, SPR stocks were 586 million barrels while industry crude stocks were only 323 million barrels.

SPR crude stocks were drawn down for the first time in 1990. The SPR stocks were at 590 million barrels at the end of October 1990. Due to the crisis in the Persian Gulf, the U.S. government made some of the crude available to the market. This was an attempt to influence the world market prices and to test the SPR mechanism. Crude prices had gone up sharply in August and September 1990 because of a fear of crude shortages in the fourth quarter of the year.

The SPR continued to be drawn down early in 1991. The SPR was reduced to 568 million barrels at the end of March 1991. The SPR has remained at this level since that time. No crude has been imported for the SPR since August 1990. The decision not to add to the SPR may be associated with trying to hold down government spending and reduce the deficit. The funds have been authorized for filling the SPR, and the fill rate generally agreed upon was 50,000–55,000 bbl/d.

The fill rate for the SPR has become sort of a political football. Those placing emphasis on energy security push for a higher fill rate. While those concerned more with government expenditures and budget deficits call for a lower fill rate or total suspension of SPR crude purchases. The domestic independent producers have asked that it be filled partially with crude from domestic stripper wells so that these wells are not shut in.

The SPR does provide a potential back up in case of an emergency. However, at year end 1990 it represented only about 34.5 days of supply at the 1990 rate of demand. One of the biggest problems with the SPR program is that there is no clear cut procedure for its use in case of an emergency. Without some program for implementation, the SPR is of little use in preventing a surge in prices if there is a supply disruption and the market gets out of balance. The recent test of using the SPR may go a long way toward correcting this problem. However, the SPR has to be used very quickly after the onset of a crisis to prevent a rapid increase in prices.

There is an additional element of supply, primarily processing gain from refining operations. This expansion during crude processing added about 950,000 bbl/d to supply in 1990. It is anticipated that with demand going up and demand for light products growing, processing gain will move up.

An added element of risk was added to the crude supply market and refinery crude trading operations during the past several years. The excess capacity situation in the world crude market led to a very competitive trading atmosphere in crude oil and petroleum products. This resulted in the rapid expansion of spot market transactions and the development of a futures market for major products and crude oil. Transactions became dominated by spot market trading and/or supply contracts with the price connected to the spot market. The net-back pricing arrangements eliminated some of the risk for refiners during 1986. But those arrangements were short lived since they tended to put additional downward pressure on prices by encouraging product price competition.

Although OPEC is trying to reestablish posted contract prices, the vast majority of the trading is still a form of spot market trading with its inherent risks. More and more refiners and others involved in trading products or crude are turning to the futures market to reduce the risk.

The futures market is not a source of supply, but it does influence prices and therefore supply decisions. Total annual contract volumes for crude and products traded on the New York Mercantile Exchange moved up rapidly. It went from 50,000 contracts in 1978 (50 million barrels) to 6,989,000 contracts in 1985, 12,858,000 in 1986, 20,931,000 in 1987, 26,945,000 in 1988, 30,263,000 contracts in 1989, and 34,985,000 contracts in 1990. The futures market has become an important barometer of the volatile movement in prices in today's market.

OUTLOOK

The worldwide oil market went through a major trauma during the past year. The upheaval in the Persian Gulf removed a substantial portion of the excess capacity that had been overhanging the market since 1986. The immediate reaction to the loss of this production was a sharp increase in the price of crude oil on world markets. The average price of world export crude oil jumped more than 50% in three weeks. Prices on the futures market moved up over $38/bbl, the highest price since 1985. The U.S. average wellhead price of crude oil followed world prices and also moved up sharply.

Initially following the war, crude prices fell. But then they leveled off and were stable for most of 1991. The prices stabilized at a level higher than prior to the war but much lower than the highs during the conflict. One of the outcomes of the conflict seemed to be a temporary stabilization of world oil markets. The stabilization seems to have been a result of both the reduction of worldwide excess capacity and the willingness of some OPEC countries to supply the market at relatively reasonable prices.

The transitions in the world oil market have an immediate impact on the U.S. supply situation. The stabilization of crude oil prices at a slightly higher level could give a boost to the U.S. crude oil market. The higher price level could boost exploration and drilling activity in the United States. The additional revenues flowing into the production sector of the market would make additional funds available for exploration or enhanced recovery. The stability also would make it easier to evaluate the economics of increased investment.

However, this stability is not expected to last for an extended period. Additional capacity is expected to be available to the market quite early in the forecast period. However, there may now be a greater willingness for the OPEC countries to cooperate and stabilize the market.

The following scenario includes the expectations for the U.S. crude supply market during the forecast period.

Base Scenario — Worldwide crude oil production capacity is expected to move up during the forecast period. A substantial increase in capacity is expected during the early years of the period. A number of the major OPEC producers with large reserves have announced plans to boost production capacity in the near future. In addition, more than 5 million bbl/d of capacity in Kuwait and Iraq is expected to become available in 1992 and 1993.

The additional capacity is expected to put downward pressure on prices throughout the forecast period, particularly in the first two

years. The increase in capacity in the early years of the forecast period are expected to move up much faster than demand. Therefore, in these two years crude oil prices are expected to fall. The average wellhead price of U.S. crude oil is projected to fall from an estimated $16.80/bbl in 1991 to $16.10/bbl in 1992 and $15.20/bbl in 1993. The price of West Texas Intermediate crude oil is projected to fall from $20.25/bbl in 1991 to $19.60/bbl in 1992 and $18.80/bbl in 1993. Average prices will fall about 7.2% during the two years.

Prices will move up gradually throughout the remainder of the forecast period due to increased U.S. and worldwide demand for crude oil. During the forecast period the increased demand for petroleum products is expected to help reduce the worldwide excess crude capacity that is putting the downward pressure on prices. The average U.S. wellhead price of crude oil is projected to move up to $18.90/bbl in 1996. The price of West Texas Intermediate will move up to $22.80/bbl. Average prices in 1996 are projected to be only 12.6% higher than 1991.

The impact on domestic supply will be influenced by the oil price. The expected trend in prices will stimulate petroleum product demand. Prices are expected to remain relatively low throughout the forecast period and this will encourage oil consumption.

However, the lower oil prices are not expected to be a major stimulus for domestic supply. That sharp drop in crude oil prices in 1986 brought the decline curve back into projections of U.S. domestic crude oil production. The lower price level stopped a great deal of exploration and drilling activity. It also slowed enhanced recovery projects and a lot of remedial work on older wells. A vast number of small stripper wells were abandoned.

The decline in U.S. production is expected to continue at varying rates throughout the forecast period and beyond. The projected increase in crude oil prices is expected to result in additional exploration and production activity. However, the increase will not be sufficient to prevent the decline in U.S. output. Lower-48 output will continue the slide that was restarted in 1986.

Adding to the problem is the peaking and decline of Alaskan output. Prudhoe Bay production has already peaked. Without additional exploration activity, total Alaskan production hit its peak in 1988 and has already begun to decline.

The decline rate may be slowed somewhat due to the slightly higher price level. Additional drilling, increased secondary recovery activity, and a longer life for stripper wells will result in more production than under a lower price scenario. But it will be impossible to stop the slide under these economic conditions. A massive exploration and drilling effort would have to be launched in order to eliminate the decline. Replacing reserves is essential to the long-term viability of the domestic industry and to U.S. energy security. But worldwide economic forces do not presently support exploitation of these higher cost domestic resources. If the energy security issue is of concern, then the government will have to take action to assist the industry by reducing the tax burden and in some cases eliminating other restrictions such as excessive environmental impediments.

Something will to have to be done about the developing obstruction to exploration activity because of environmental concerns. Some serious economic analysis is going to have to be done to balance the twin goals of economic growth and protecting the environment in a totally pristine state.

U.S. crude production will not be greatly affected by the trend in crude prices during the forecast period. There will be an increase in exploration and drilling activity, but it will not be sufficient to do much but slightly slow the

decline in U.S. output. U.S. domestic crude oil production will fall throughout the forecast period. Domestic output at the end of the forecast period, 1996, will be down 11.4% at 6.5 million bbl/d. This is a drop of 840,000 bbl/d during the five years 1991–1996. Total liquids production, crude oil plus natural gas liquids, will fall 880,000 bbl/d, 9.7%, to 8.16 million bbl/d.

Lower domestic production and increasing domestic demand will result in an ever widening gap between domestic supply and demand. And this gap will have to be filled by imports. U.S. dependency on imported oil will move up during the forecast period because of the same reasons, increasing U.S. demand for petroleum products and declining domestic liquids production.

Total industry imports, excluding crude imports for the SPR are projected to increase 27.9% during the forecast period 1992–1996. Total industry imports will move up to 9.86 million bbl/d, an increase of 2.15 million bbl/d. With lower product and crude oil prices in 1992 and 1993, demand will be moving up. Imports will move up as the gap grows between demand and slumping domestic crude oil production. The price increases that are projected from 1994 through 1996 are not expected to slow demand growth markedly. Imports will continue to grow throughout the forecast period as U.S. production continues to slide. Imports will set a record high when they reach 9.035 million bbl/d in 1994. The previous annual record was 8.786 million bbl/d in 1977. Total oil imports are projected to move up 27.9%, 2.15 million bbl/d, to 9.86 million bbl/d in 1996. This obviously will also be a new record high for oil imports.

Crude oil imports are projected to move up 26.2% during the forecast period to 7.46 million bbl/d in 1996, an increase of 1.55 million bbl/d. This will be a record high for crude oil imports. The previous high was 6.594 million bbl/d, also in 1977. New record highs will be reached by 1994.

With substantial refining capacity available in the United States, refiners prefer to import crude rather than products. Therefore, product imports do not usually move up as rapidly as crude imports. However, refining capacity is not expected to increase much during the forecast period. Therefore product imports are forecast to move up more rapidly than crude oil imports during the forecast period 1992–1996. Product imports are projected to increase 33.3% to 2.4 million bbl/d in 1996.

With declining U.S. production and increasing imports, dependency on imported oil will increase markedly. Total imports as a percentage of domestic demand will move up from 46.2% in 1991 to 54.3% in 1996. This will be an all time high. Net imports (total imports less exports), as a percentage of domestic demand, will increase from 40.3% in 1991 to 49.7% in 1996. This will be a record high also.

Crude imports as a percentage of total U.S. crude supply is projected to move up from 44.6% in 1991 to 53.4% in 1996.

By the end of the forecast period, the United States will be more dependent on foreign oil than in the late 1970s. And the dependency will be on the rise with no end in sight.

The dependency will be on OPEC oil and will probably make the imports more vulnerable to supply disruptions and the economy more vulnerable to energy disruptions. Since non-OPEC production is not expected to increase during this period, the additional imports will have to come mainly from OPEC sources. Imports from OPEC countries are expected to increase to over 60% of total U.S. imports by the end of the forecast period.

Stocks will not play a major role in the supply picture during the forecast period. Stocks are presently at close to a minimum level for operational efficiency. Expectations are that stocks will be increased as demand moves up.

U.S. SUPPLY

KEYS TO THE FUTURE

1. The worldwide crude oil production capacity will move up sharply in 1992 and 1993 and then increase gradually during the forecast period. Capacity will increase faster than demand, and substantial excess capacity will develop. This will put downward pressure on crude oil prices throughout the forecast period. The worldwide export price for crude oil will fall in 1992 and 1993 and then increase through 1996.

2. The average U.S. wellhead price of crude oil will follow the worldwide export prices, falling in 1992 and 1993 and then rising through 1996. Increased U.S. and worldwide demand for petroleum products and crude oil will result in a gradual increase in prices during the latter part of the forecast period. The price will move up somewhat slower than the rate of inflation. The price level will remain dependent upon international market conditions and OPEC actions.

3. The projected price level will not give much of a boost to U.S. exploration, drilling, and production activities. Prices will move up during the forecast period, but the price rise will not be sufficient to stimulate a level of activity that would have a major impact on domestic production trends. However the prices will be high enough to encourage some investment in new technology for drilling and enhanced production.

4. Production in the lower-48 states will continue to decline. The rate of decline will be slowed a bit by increased drilling and other production activities. Alaskan production peaked in 1988 and will also decline during the forecast period. The rate of decline in Alaska will depend upon future exploration activities. And future exploration activity will depend upon how the environmental issues are resolved. Total U.S. crude production will fall to 6.5 million bbl/d in 1996, down 11.4%, 840,000 bbl/d during the five years. This will be the lowest output since 1954.

5. Total imports will increase to fill the gap between increasing domestic demand and declining domestic production. Total imports will set a record high by 1994. Imports will move up 27.9% to 9.86 million bbl/d in 1996. Crude imports will move up to 6.5 million bbl/d in 1996, up 11.4%.

6. Dependency on imports will hit record highs during the forecast period. Total imports as a portion of domestic demand will move up to 54.3% in 1996. Most of the increase in imports will come from OPEC countries.

7. Product imports also will move up during the forecast period. The domestic refining industry capacity will not move up as rapidly as demand. Some minor increase in refining capacity is expected. The industry will continue to operate as efficiently as possible, minimizing stock levels and carrying costs and trying to maximize the utilization rate.

THE OUTLOOK — U.S. SUPPLY

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
PETROLEUM BALANCE									
(thousands barrels/day)									
DEMAND:									
Domestic demand	16,988	16,695	16,970	17,285	17,580	17,875	18,175	+ 1,480	+ 8.9
Exports	857	975	890	870	850	835	825	– 150	– 15.4
Total demand	**17,845**	**17,670**	**17,860**	**18,155**	**18,430**	**18,710**	**19,000**	**+ 1,330**	**+ 7.5**
SUPPLY:									
Crude production	7,355	7,340	7,140	6,950	6,800	6,650	6,500	– 840	–11.4
NGL & other hydrocarbons	1,639	1,700	1,650	1,655	1,655	1,660	1,660	– 40	– 2.4
Total liquids production	**8,994**	**9,040**	**8,790**	**8,605**	**8,455**	**8,310**	**8,160**	**– 880**	**– 9.7**
Crude imports (ex SPR)	5,867	5,910	6,160	6,540	6,835	7,160	7,460	+1,550	+ 26.2
Product imports	2,124	1,800	2,000	2,100	2,200	2,300	2,400	+ 600	+33.3
Total industry imports	**7,991**	**7,710**	**8,160**	**8,640**	**9,035**	**9,460**	**9,860**	**+2,150**	**+27.9**
Other supply	952	935	950	965	980	995	1,010	+ 75	+ 8.0
Total supply	**17,937**	**17,685**	**17,900**	**18,210**	**18,470**	**18,765**	**19,030**	**+1,345**	**+ 7.6**
TOTAL STOCKS:									
(million barrels-year end)									
Crude oil	323	340	345	355	360	370	370	+30	+8.8
Petroleum products	712	700	710	720	730	740	750	+ 50	+ 7.1
Total industy stocks	**1,035**	**1,040**	**1,055**	**1,075**	**1,090**	**1,110**	**1,120**	**+ 80**	**+ 7.7**
SPR crude oil stocks	586	573	590	610	630	650	670	+ 97	+16.9
Total U.S. stocks	**1,621**	**1,613**	**1,645**	**1,685**	**1,720**	**1,760**	**1,790**	**+177**	**+11.0**
Industry stocks - days supply	60.9	62.3	62.2	62.2	62.0	62.1	61.6	–0.7	–1.1
IMPORT DEPENDENCY									
Net imports - % of domestic demand	42.0	40.3	42.8	45.0	46.6	48.3	49.7	+ 9.4	+ 23.3
Total imports - % of domestic demand	47.0	46.2	48.1	50.0	51.4	52.9	54.3	+ 8.1	+17.5
Crude imports - % of crude supply	44.4	44.6	46.3	48.5	50.1	51.8	53.4	+ 8.8	+19.7
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	20.03	16.80	16.10	15.20	16.60	17.50	18.90	+ 2.10	+12.5
West Texas intermediate (posted)	23.17	20.25	19.60	18.80	20.30	21.30	22.80	+2.55	+12.6

OUTLOOK 2000 — U.S. SUPPLY

	1990	1995	2000	Change 1990 to 1995	Change 1995 to 2000	Change 1990 to 2000	% change 1990 to 1995	% change 1995 to 2000	% change 1990 to 2000
PETROLEUM BALANCE									
(thousands barrels/day)									
DEMAND:									
Domestic demand	16,988	17,875	18,820	+ 887	+ 945	+ 1,832	+ 5.2	+ 5.3	+ 10.8
Exports	857	835	860	− 22	+ 25	+ 3	−2.6	+ 3.0	+ 0.4
Total demand	**17,845**	**18,710**	**19,680**	**+ 865**	**+ 970**	**+ 1,835**	**+ 4.8**	**+ 5.2**	**+ 10.3**
SUPPLY:									
Crude production	7,355	6,650	5,950	− 705	− 700	− 1,405	− 9.6	− 10.5	−19.1
NGL & other hydrocarbons	1,639	1,660	1,680	+ 21	+ 20	+ 41	+ 1.3	+ 1.2	+ 2.5
Total liquids production	**8,994**	**8,310**	**7,630**	**−684**	**−680**	**−1,364**	**− 7.6**	**− 8.2**	**−15.2**
Crude imports (ex SPR)	5,867	7,160	8,140	+1,293	+ 980	+2,273	+22.0	+13.7	+38.7
Product imports	2,124	2,300	2,890	+ 176	+ 590	+766	+ 8.3	+25.7	+ 36.1
Total industry imports	**7,991**	**9,460**	**11,030**	**+ 1,469**	**+ 1,570**	**+ 3,039**	**+ 18.4**	**+ 16.6**	**+38.0**
Other supply	952	995	1,050	+ 43	+ 55	+ 98	+ 4.5	+ 5.5	+10.3
Total supply	**17,937**	**18,765**	**19,710**	**+ 828**	**+ 945**	**+ 1,773**	**+ 4.6**	**+ 5.0**	**+ 9.9**
TOTAL STOCKS:									
(million barrels-yearend)									
Crude oil	323	370	380	+ 47	+ 10	+ 57	+ 14.6	+ 2.7	+ 17.6
Petroleum products	712	740	790	+ 28	+ 50	+ 78	+ 3.9	+ 6.8	+ 11.0
Total industry stocks	**1,035**	**1,110**	**1,170**	**+ 75**	**+ 60**	**+ 135**	**+ 7.2**	**+ 5.4**	**+ 13.0**
SPR crude oil stocks	586	650	740	+ 64	+ 90	+ 154	+ 10.9	+ 13.8	+ 26.3
Total U.S. stocks	**1,621**	**1,760**	**1,910**	**+ 139**	**+ 150**	**+ 289**	**+ 8.6**	**+ 8.5**	**+ 17.8**
Industry stocks — days supply	60.9	62.1	62.2	+ 1.2	+ 0.1	+ 1.3	+ 2.0	+ 0.2	+ 2.1
IMPORT DEPENDENCY									
Net imports - % of domestic demand	42.0	48.3	54.0	+ 6.3	+ 5.7	+ 12.0	+ 15.0	+ 11.8	+ 28.6
Total imports - % of domestic demand	47.0	52.9	58.6	+ 5.9	+ 5.7	+ 11.6	+ 12.6	+ 10.8	+ 24.7
Crude imports - % of crude supply	44.4	51.8	57.8	+ 7.4	+ 6.0	+ 13.4	+ 16.7	+ 11.6	+ 30.2
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	20.03	17.50	23.75	− 2.53	+ 6.25	+ 3.72	−12.6	+ 35.7	+ 18.6
West Texas intermediate (posted)	23.17	21.30	28.90	−1.87	+ 7.60	+ 5.73	− 8.1	+ 35.7	+ 24.7

CAPITAL EXPENDITURES

The outcome of the conflict in the Middle East seems to have left the oil market in a much more stable condition. Excess production capacity has been temporarily eliminated and world oil prices have been stabilized, and stabilized at a level higher than in the recent past. Also encouraging is the fact that OPEC has not taken advantage of the tight market conditions to try to boost prices sharply and upset the market.

U.S. CAPITAL SPENDING

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
					(Million $)					
Drilling-Exploration	43,193	44,251	28,193	28,290	26,596	14,651	11,377	13,542	12,360	13,064
Production	7,984	8,681	5,531	5,590	5,217	3,066	2,297	2,657	2,475	3,957
OCS lease bonus	6,653	3,987	5,749	3,029	1,558	187	497	1,256	646	663
Subtotal	**57,830**	**56,919**	**39,473**	**36,909**	**33,371**	**17,904**	**14,171**	**17,455**	**15,481**	**17,684**
Refining	5,131	4,710	4,142	2,914	2,992	2,073	2,180	2,874	3,167	4,402
Petrochemicals	2,792	1,570	1,112	1,215	1,493	1,357	1,248	1,962	2,715	3,125
Marketing	1,619	1,337	1,614	2,221	2,611	1,634	1,810	2,525	2,613	2,702
Crude & products pipelines	2,052	1,320	2,456	1,689	1,137	435	733	400	451	500
Natural Gas pipelines	4,947	6,070	4,707	3,971	2,084	1,309	1,556	1,659	969	1,982
Other transportation	895	515	456	386	458	380	310	416	498	547
Mining & other energy	4,233	3,524	1,757	1,883	1,239	1,277	1,229	1,165	885	873
Miscellaneous	3,498	4,284	2,810	2,464	2,467	1,981	1,951	2,292	2,626	2,993
Subtotal	**25,167**	**23,330**	**19,054**	**16,743**	**14,481**	**10,446**	**11,017**	**13,293**	**13,924**	**17,224**
Total	**82,997**	**80,249**	**58,527**	**53,652**	**47,852**	**28,350**	**25,188**	**30,748**	**29,405**	**34,908**

Source: Oil & Gas Journal

Revenue flowing into the industry is higher than it has been in recent years, and there is some expectation that demand will be growing in future years. The revenue flowing into the industry is a key determinant of the investment level. And the anticipation of increased energy, and oil and gas demand, should provide a positive framework for investment planning.

Investment in the U.S. oil and gas industry has gone through an extremely volatile period during the past 10–15 years. Capital and exploration expenditures in the oil and gas industry have taken some sharp swings. The level of outlays has been closely tied to the amount of money flowing through the industry and the level of profitability. It has been most closely tied to the cash flow in the producing sector of the industry. And the cash flow has been determined to a great extent by the price level for crude oil and natural gas.

Prior to the 1970s there was relatively little price movement. Change in industry cash flow was determined by the change in the demand for crude, petroleum products, and natural gas. And since this was an era of constantly rising demand, cash flow into the industry was steadily rising also. During this period, investment decisions were based upon the expectations of increasing demand. This was true of investment in the United States and throughout other areas of the world.

A change occurred in the 1970s. In the first part of the decade, prices, demand, and cash flow all moved up very rapidly. Capital expenditures followed and also moved up rapidly. This was particularly true following the price hikes in the periods 1973–1974 and 1978–1980.

The biggest change from this historical trend came about following the 1978–1980 increase in prices. Demand hit a peak in 1978 and started to slide. This was unprecedented in the industry. The industry did not recognize that demand had hit a peak and was still reacting to the huge jump in prices. OPEC producers continued to push up prices and continued testing the market. Therefore cash flow into the industry continued to move up. Capital expenditures followed prices and cash flow. But at that time, the increase was no longer tied to an industry with increasing demand. Prices and capital spending did not peak until 1981. Both prices and spending exhibited a delayed reaction to the downturn in consumption of petroleum products.

U.S. oil and gas industry capital expen-

ditures dropped continuously from 1980 through 1987, generally following the trend in crude oil and natural gas prices. However, another shift in direction appears to be occurring as oil, natural gas, and product demand move up and require additional investment for the expanded activity.

REVIEW

During the past 10–15 years, the price of crude oil has led U.S. oil and gas industry capital expenditures through a cycle of huge amplitude. For the industry it has been a boom-bust period of historic proportions.

Starting in the late 1970s, rapidly rising prices led the way to a huge increase in investment. The average wellhead price of domestic crude oil went up from $9.00/bbl in 1978 to $31.77/bbl in 1981. This was a jump of $22.77/bbl, 253%, in just 3 years. The average cost of imported crude oil increased from $13.30/barrel in 1978 to $35.10/barrel in 1981, an increase of 163.9%. The average refiner acquisition cost of crude oil, both domestic and imported, increased from $12.46/barrel in 1978 to $35.24/barrel in 1981, an increase of 182.8%.

It should be noted that in 1978 there were still price controls on some domestic U.S. production, and therefore the average domestic price remained below the world price until controls were lifted in 1981.

During this short 3-year span, the total value of U.S. crude production at the wellhead went up from $13.1 billion in 1973 to $28.6 billion in 1978. It then jumped to $99.4 billion in 1981. This came about even though U.S. crude production in 1981 was down 6.9% from 1973 and down 1.6% from 1978.

Based only on wellhead value from domestic production, industry revenues were up $86.3 billion from 1973 and up $70.8 billion from 1978. When refined product sales are taken into consideration, the increased revenue was much greater. Product prices moved up along with crude prices and contributed even more to the substantial increase in the revenues flowing into the oil industry.

In response to this tremendous surge in industry revenue, industry capital spending shot up. Over the same 3-year span, total U.S. oil industry capital spending went from $29.2 billion to $82.9 billion, an increase of 184.1%.

During this upswing portion of the cycle, 1978 through 1981, exploration, drilling, and production spending (including OCS lease bonus payments) increased from $20 billion to $57.8 billion, an increase of 189.2%. Spending on exploration and drilling activities alone increased from $15.1 billion in 1978 to $43.2 billion in 1981, an increase of 186.4%. Production outlays increased 154.9% to $8.0 billion in 1981. And OCS lease bonus payments by the industry jumped to $6.6 billion in 1981, up from $1.8 billion in 1978.

With these lofty prices for crude oil and rising natural gas prices, there were many more production prospects that were economical for development. Even very marginally producing wells could be economically justified and considered potentially profitable.

Capital outlays also were being driven up by the expectations at that time of substantially higher prices in future years. As a result of these optimistic projections, there was also a lot of additional outside capital flowing into exploration and production activity. With higher prices, the cash flow into the industry moved up, and this was combined with substantially more outside funds available for investing.

With funds available, companies were also expanding and upgrading other aspects of

U.S. CAPITAL SPENDING (CONSTANT DOLLARS)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
					(Million $)					
PPI*	0.980	1.000	1.013	1.037	1.032	1.002	1.028	1.069	1.122	1.163
Drilling & exploration	44,074.5	44,251.0	27,831.2	27,280.6	25,771.3	14,621.8	11,067.1	12,667.9	11,016.0	11,233.0
Production	8,146.9	8,681.0	5,460.0	5,390.5	5,055.2	3,059.9	2,234.4	2,485.5	2,205.9	3,402.4
OCS lease bonus	6,788.8	3,987.0	5,675.2	2,920.9	1,509.7	186.6	483.5	1,174.9	575.8	570.1
Subtotal	**59,010.2**	**56,919.0**	**38,966.4**	**35,592.1**	**32,336.2**	**17,868.3**	**13,785.0**	**16,328.3**	**13,797.7**	**15,205.5**
Refining	5,235.7	4,710.0	4,088.8	2,810.0	2,899.2	2,068.9	2,120.6	2,688.5	2,822.6	3,785.0
Petrochemicals	2,849.0	1,570.0	1,097.7	1,171.6	1,446.7	1,354.3	1,214.0	1,835.4	2,419.8	2,687.0
Marketing	1,652.0	1,337.0	1,593.3	2,141.8	2,530.0	1,630.7	1,760.7	2,362.0	2,328.9	2,323.3
Crude & prod. pipelines	2,093.9	1,320.0	2,424.5	1,628.7	1,101.7	434.1	713.0	374.2	402.0	429.9
Natural Gas pipelines	5,048.0	6,070.0	4,646.6	3,829.3	2,019.4	1,306.4	1,513.6	1,551.9	863.6	1,704.2
Other transportation	913.3	515.0	450.1	372.2	443.8	379.2	301.6	389.1	443.9	556.3
Mining & other energy	4,319.4	3,524.0	1,734.5	1,815.8	1,200.6	1,274.5	1,195.5	1,089.8	788.8	750.6
Miscellaneous	3,569.4	4,284.0	2,773.9	2,376.1	2,390.5	1,977.0	1,897.9	2,144.1	2,340.5	2,573.5
Subtotal	**25,680.6**	**23,330.0**	**18,809.5**	**16,145.6**	**14,032.0**	**10,425.1**	**10,716.9**	**12,435.0**	**12,410.0**	**14,810.0**
Total	**84,690.8**	**80,249.0**	**57,775.9**	**51,737.7**	**46,368.2**	**28,293.4**	**24,501.9**	**28,763.3**	**26,207.7**	**30,015.5**

*Producer's Price Index (1982 = 1.00)

OGJ GROUP* PROFITS AND CAPITAL SPENDING

	Net income (Million $)	Capital & exploratory expenditures (Million $)	Capital & exploration expenditures % of net income
1978	13,779.0	42,265.0	306.7
1979	23,130.0	53,261.0	230.3
1980	29,326.8	52,065.0	177.5
1981	28,205.4	66,835.8	237.2
1982	23,079.7	60,357.9	261.5
1983	22,325.5	45,584.1	204.2
1984	20,078.1	51,422.8	256.1
1985	15,801.5	50,907.5	322.2
1986	10,893.7	33,620.2	308.6
1987	8,370.4	32,079.3	383.2
1988	21,835.8	39,261.9	179.8
1989	18,881.0	41,916.8	222.0
1990	21,495.9	42,800.6	199.1
Total 1978-1990	**257,282.8**	**612,437.0**	**238.1**

*Oil & Gas Journal group of 25-28 major oil companies.

Source: Oil & Gas Journal

their operations: refining, petrochemicals, marketing, and transportation. In addition, some companies were diversifying into other industries, such as mining, and into other activities outside natural resource development.

Spending for all of the other segments of the industry also increased. Outlays for refining, marketing, transport, etc., moved up from $9.2 billion in 1978 to $25.2 billion in 1981, an increase of 173.2%.

DECLINE IN INDUSTRY INVESTMENTS. Demand peaked in the United States in 1978, and prices peaked in March of 1981. These two events started a slide in industry investments that lasted for several years. The drop in prices and demand resulted in a large reduction in the cash flow into the U.S. oil and gas industry and therefore a reduction in the funds available for capital and exploration spending.

As a result, U.S. oil and gas industry capital and exploration expenditures plummeted from the lofty levels of the 1981 and 1982 boom years. Capital spending by U.S. oil companies peaked in 1981 at $82,997 million. It fell to $80,249 million in 1982 and then dropped sharply to $58,527 million in 1983. Spending dropped in 1984 to $53,652 million and slipped again to $47,852 million in 1985. Natural gas prices continued to move up until 1984 and provided a small offset to declining crude oil revenues, but this wasn't sufficient to stop the decline in cash flow.

When prices plummeted in 1986, capital spending followed, dropping precipitously to an estimated $28,350 million. Prices moved

INTERNATIONAL SPENDING – U.S. FIRMS

	1984	1985	1986	1987	1988	1989	1990	1991	1992
					(Million $)				
Exploration-Production									
Drilling-Exploration	5,471	5,238	3,590	3,679	3,586	4,070	4,806	5,810	6,300
Production	2,706	2,688	2,322	2,472	3,020	3,355	4,835	6,648	7,800
Subtotal	**8,177**	**7,926**	**5,912**	**6,151**	**6,606**	**7,425**	**9,641**	**12,458**	**14,100**
Other									
Refining	795	959	716	471	822	963	1,055	1,130	1,220
Petrochemicals	438	245	360	436	589	725	954	881	820
Marketing	629	932	878	1,054	1,214	1,527	1,611	1,853	1,990
Pipelines	159	215	139	111	136	142	220	222	230
Other transportation	27	154	43	61	151	162	158	208	270
Mining & other energy	750	816	655	336	223	628	480	590	650
Miscellaneous	274	486	211	217	425	288	503	408	400
Subtotal	**3,072**	**3,807**	**3,002**	**2,686**	**3,560**	**4,445**	**4,981**	**5,292**	**5,580**
Total	**11,249**	**11,733**	**8,914**	**8,837**	**10,166**	**11,870**	**14,622**	**17,750**	**19,680**

Source: Oil & Gas Journal

up a bit in 1987, but investors were still wary of the crash the previous year. Capital spending slipped to $25,188 million. Spending in 1987 was below the level 10 years earlier, 1977, when outlays totaled $26,691 million. Spending in 1987 was down $57,809 million from the peak in 1981.

Total spending moved up in 1988 for the first time since the 1981 peak year. A rise in oil prices in 1987 and increased profitability stimulated additional investment in 1988. Spending increased to $30,748 million.

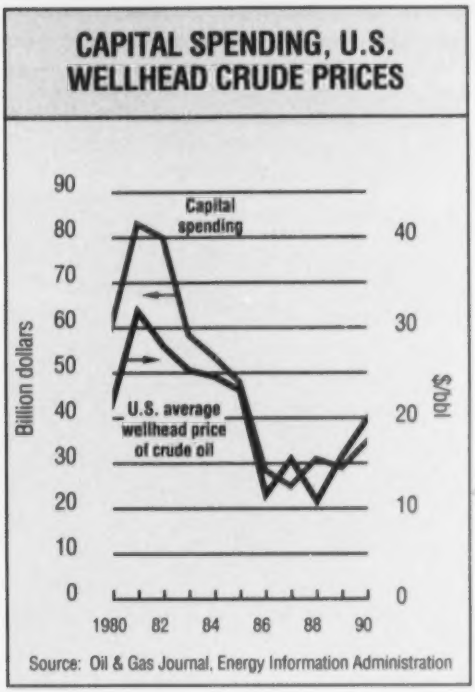
During the years of declining outlays, 1981–1987, total exploration drilling and production outlays declined $43.7 billion, 75.5% of the total decline. Spending in this sector of the business fell from $57.8 billion in 1981 to an estimated $14.2 billion in 1987. This was a drop of 75.5% in the 6 years. Outlays in this area fell $15.5 billion in 1986 alone.

Spending on other activities downstream also fell dramatically but not as rapidly as exploration and production. All of the other capital spending together fell, 56.2% from $25,167 million in 1981 to $11,017 million in 1987, a drop of $14,150 million.

Capital spending fell at about the same rate as crude prices. The average wellhead price of domestic crude oil fell from $31.77/bbl in 1981 to $12.51/bbl in 1986, a decline of 60.6%. Natural gas prices also began to fall in 1984, and the average wellhead price in 1986 was down 29.7% from the peak. During this same period there was also a drop in demand for petroleum products and natural gas, so the cash flow impact was greater than reflected in just the price change.

Crude prices moved up in 1987, slumped again in 1988, and then moved back up to $15.85/bbl in 1989. In 1990 the conflict in the Middle East boosted oil prices, and the average wellhead price moved up to $20.03/bbl. Natural gas prices continued to fall through 1987, down to $1.67/mcf. But they seemed to have bottomed out at that level and have moved up slightly to $1.69/mcf in 1988 and 1989, and $1.72/mcf in 1990. Crude production has been falling in these years while natural gas production has been on the rise. With these trends there has not been any great surge of cash into the industry that would stimulate a large increase in capital spending. Industry total capital spending did move up to $30,748 million in 1988 but then slipped to $29,405 million in 1989. Outlays moved back up to $34,908 million in 1990.

Spending on exploration, drilling, and production activities moved up to $16,199 million in 1988 but then dropped to $14,835 mil-



lion in 1989. Spending for E&P moved up to $17,021 million in 1990.

SPENDING AND PROFITS. Corporate investment decisions are probably made with a closer eye to profits than to prices. Although industry capital spending followed crude prices closely, the spending decisions were more probably based on estimated profitability. Available funds also influence spending decisions. And crude and product prices were a major determinant of cash flow during the past 10 years. So prices probably were also a major influencing factor in the investment decisions. Capital spending tended to follow cash flow which was following the movement in prices and production.

The level of profits is determined by many factors. So although capital spending tends to follow profits, the relationship between the two in any given year can fluctuate greatly.

For the *Oil & Gas Journal* group of large integrated oil companies, during the past 12 years worldwide capital and exploration expenditures as a percentage of net income ranged from 177.5% in 1980 to 383.2% in 1987. The average from 1978 through 1989 was 241.6%.

The level of investment in any given year was dependent upon the profit picture for the individual company at that point in time. It also was influenced by the available funds and the company's outlook for the industry. Overall this group of companies has maintained a high level of capital investment relative to profits, despite the downturn in the industry. Their planning horizons tend to be relatively long range and they invest for the future.

But with the low level of prices and the outside threat of takeovers, recently the companies have been forced to adhere more closely to the short range market philosophy of the investment community. The longer range outlook might pay larger future returns, but unfortunately many investors aren't looking very far into the future.

In addition, many oil companies have been forced into reorganization to prevent hostile takeovers and dismemberment. The fall in prices and oil company revenues rapidly changed the perception that outside investors had of the future potential of the oil industry. Outside interests saw a profit opportunity in forcing rapid restructuring. This has resulted in a wave of mergers, stock repurchase plans, and other moves to fend off hostile takeovers. The result for many companies has been a substantial additional increase in debt. This has further reduced funds available for reinvestment.

In addition, companies have been restructuring since the peak period in other ways aimed at increasing profitability. They have been cutting staff levels, cutting operating

WORLDWIDE PETROLEUM INDUSTRY CAPITAL SPENDING

	1986	1987	1988	1989	1990	1991	1992
				(Million $)			
U.S. and Canada:							
Crude Oil and Natural Gas	29,150	23,940	28,320	24,920	26,650	31,300	32,850
NGL Plants	510	740	790	840	870	900	950
Refineries	2,950	3,050	3,290	3,690	4,900	6,370	6,950
Total North America	**32,610**	**27,730**	**32,600**	**29,450**	**32,420**	**38,570**	**40,750**
Mexico and Central and South America:							
Crude Oil and Natural Gas	6,930	6,180	6,125	4,695	4,510	4,900	5,100
Refineries	2,260	1,580	1,500	1,500	1,700	1,900	1,950
Total Central & S. America	**9,190**	**7,760**	**7,625**	**6,195**	**6,210**	**6,800**	**7,050**
Western Europe:							
Crude Oil and Natural Gas	11,550	12,030	13,115	11,540	11,900	13,500	14,750
Refineries	1,480	2,730	2,500	2,700	2,700	2,750	2,800
Total Western Europe	**13,030**	**14,760**	**15,615**	**14,240**	**14,600**	**16,250**	**17,550**
Middle East and Africa:							
Crude Oil and Natural Gas	3,160	2,770	2,915	2,790	2,970	3,000	3,400
Refineries	940	1,020	1,000	1,000	1,000	1,200	1,500
Total Middle East & Africa	**4,100**	**3,790**	**3,915**	**3,790**	**3,970**	**4,200**	**4,900**
Far East and Australasia:							
Crude Oil and Natural Gas	3,680	2,100	2,295	2,305	2,330	2,500	2,600
Refineries	1,860	2,040	2,000	2,050	2,100	2,150	2,250
LNG Plants	1,230	1,380	1,300	1,300	1,400	1,500	1,600
Total Far East & Australasia	**6,770**	**5,520**	**5,595**	**5,655**	**5,830**	**6,150**	**6,450**
Free World							
Crude Oil and Natural Gas	54,470	47,020	52,770	46,250	48,360	55,200	58,700
NGL Plants	510	740	790	840	870	900	950
Refineries	9,490	10,420	10,490	10,940	12,400	14,370	15,450
LNG Plants	1,230	1,380	1,300	1,300	1,400	1,500	1,600
Tankers	1,580	1,510	1,500	1,700	2,000	2,500	2,800
Total Free World	**67,280**	**61,070**	**66,850**	**61,030**	**65,030**	**74,470**	**79,500**

costs, and shedding surplus facilities. They have been somewhat preoccupied with these activities at the expense of new investing.

The exploration, drilling, and production segments of the domestic industry have been particularly hard hit by the lower prices. The lower prices have markedly reduced the wellhead revenues from crude oil and natural gas production. This has diminished the funds available for reinvestment in drilling activity. In addition, many companies have had to use available funds to reduce the debt burden incurred from the boom period.

During the boom, the expectation of higher oil prices not only increased the flow of outside capital but also encouraged a number of companies to increase their debt to expand operations. As prices fell, the debt became a prohibitive burden. The necessity to repay the debt with funds from lower valued oil has severely restricted the investment capability of many firms.

With oil prices down and pessimistic future price prospects, the flow of outside capital into the industry dried up. The glamour left oil investing. The highly speculative funds that flowed into the industry in the 1979–1982 period, in anticipation of a potential high rate of return, were being invested elsewhere.

As a result of the sharp drop in funds available to the industry, the wellhead revenue reinvestment ratio, an indicator of the attractiveness of oil investing, fell to one of the lowest levels on record. This ratio measures the percentage of total wellhead revenues that are reinvested in drilling activity. A drop in this ratio indicates a loss of confidence in investing in industry exploration.

Drilling rig activity followed the drop in the reinvestment ratio. Rig activity in 1986 fell to the lowest weekly level ever recorded, 663. This was the lowest level since the Hugh-

es Tool Company started counting active rigs on a regular basis. The rig activity has remained low and averaged only 869 active rigs in 1989. That was the lowest level since the war effort depressed drilling activity in 1942.

It appears that a cycle in U.S. oil industry investment has been completed, and the industry is back to about the point it started at in 1977. The average wellhead price for domestic crude was $15.41/bbl in 1987 and $15.85/bbl in 1989. U.S. crude prices were under some controls in 1977 and therefore are not a perfect comparison. Total capital and exploration spending in 1989 was $29,405 million. Total spending in 1977 was $26,691 million. The industry turned up in 1978, and there are presently some positive signs. However, any enthusiasm about the future has to be tempered since it is doubtful that there will be a rapid increase in spending.

SPENDING OUTSIDE THE UNITED STATES. With the sharp drop in prices, there has been a shift in investment spending to the lower cost areas outside the United States. In recent years the U.S. international companies have been spending a greater portion of their capital budgets outside the United States. International spending by a group of U.S. companies has been on the rise since 1987. Spending outside the United States by this group has risen from $8,837 million in 1987 to an estimated $11,870 million in 1989 and $12,914 million in 1990. This is an increase of 46.1% during the past three years. Plans call for this group to boost spending to $14,590 million in 1991.

Spending on exploration and production activities moved up from $6,151 million in 1987 to $9,001 million in 1990. Plans call for this to move up to $10,470 million in 1991.

These companies are finding investments in lower cost non-U.S. areas to be more attractive than domestic investment. In addition, many non-OPEC countries are offering better investment terms to companies willing to explore in their country. When prices dropped, some of these countries saw investment dry up in their oil industries. The international companies did not find investing very profitable under the stringent financial terms that existed in past years.

Total worldwide petroleum industry capital spending fell off sharply after prices plummeted in 1986. Total investment fell from $91 billion in 1985 to $61.07 billion in 1987. When prices rebounded in 1987, it stimulated spending the following year, and total capital spending increased to $66.85 billion in 1988. But prices fell in 1988 and spending dipped in response to $61.03 billion in 1989. Spending for 1990 is estimated at $65.03 billion. Worldwide spending is expected to move up the next couple of years along with demand for petroleum and natural gas. Worldwide capital spending is expected to move up to $74.47 billion in 1991 and $79.5 billion in 1992.

OUTLOOK

The positive resolution of the conflict in the Middle East has helped to stabilize the worldwide oil industry. After falling immediately following the conflict, world crude oil prices have been relatively stable for the remainder of the year. OPEC has been cooperative and has boosted production to make up for the shortfall caused by the loss of production from Iraq and Kuwait.

Expectations now are that demand for oil and natural gas will be moving up along with future economic growth. This will result in more demand for services from all segments

of the industry. To meet this demand will require a substantial investment in new and/or upgraded facilities.

The outlook for the industry has been improving in recent years and that may mean the start of a new investment cycle. However it is doubtful that the upswing portion of the cycle will be as volatile as the one that started in the 1970s. But conditions are favorable for a substantial increase in industry activity over the next several years. Prices are expected to move up only modestly during the forecast period. Demand for petroleum products is again on the rise, although there continues to be competition from other fuels which will hold down the rate of increase.

In recent years companies have been somewhat preoccupied with other concerns. The last few years have been a period of adjustment for companies in the industry. It was necessary for most companies to restructure and cut costs sharply. That led to a reduction in capital investment. The effects of the cost cutting are now beginning to show up in improved profits and some increased investments. In addition, as companies reduce the heavy debt load brought on by restructuring, investment can be increased. In addition, the lower debt load and improved profits should attract additional outside funds into the industry.

It is not expected that there will be anything close to the surge in spending that occurred during the 1980–1982 period. It is expected that capital expenditures will closely follow revenue and price movements, economic activity, and energy and oil demand. Capital spending in the U.S. oil and gas industry will move the way of prices and profits during the forecast period.

Base Scenario — Total capital and exploration spending is projected to move up steadily during the forecast period, up 36.6% at the end of the period in 1996. Spending in 1996 will total $50.605 billion. This will be up $13.6 billion from 1991. The stabilization of prices at an acceptable level in 1991 gave a boost to investment because of the additional funds available to the industry and the reduction in uncertainty and risk. The expected fall in prices in 1992 is not expected to result in a reduction in investment. Increased demand and continued stability will help stimulate investment. Over the remainder of the forecast period, spending is also expected to move up along with prices and demand.

Spending is expected to increase much faster than prices. Spending is at a relatively depressed level now so an increase to more normal levels will result in a faster growth rate. Domestic crude oil prices at the end of the forecast period are projected to be up 12.5% from 1991. Natural gas prices will increase 54.8% to $2.40/mcf in 1996. Motor gasoline pump prices will be up 8% from 1991 at $1.35/gal.

U.S. domestic expenditures for exploration and production activities will also tend to follow the movement of oil prices during the forecast period but are expected to increase much faster. Spending in this sector of the domestic industry also will increase even though prices will be weak. Exploration and production spending will move up steadily during the forecast period. The reinvestment ratio for the industry is quite low at present. Both cash flow into the industry and the percentage reinvested are expected to increase during the next five years. The annual level of spending on exploration, drilling, production, and OCS lease bonuses is forecast to increase 48.3% during the five-year forecast period. Spending will increase to $25.36 billion in 1996, up $8.255 billion from 1991.

Spending for just the exploration and drilling segment is projected to increase 43.6%, up $5,630 billion to $18.55 billion in 1996. The

expected price rise for crude oil and natural gas will stimulate drilling activity. And as prices move up, some outside investment funds will return to the industry. This will be particularly true in the later years if prices move up more rapidly. The independent sector of the U.S. domestic industry does the majority of the drilling but relies heavily on outside investment funds. When prices appear a bit more certain, investors will return and activity and investment by the independents is expected to increase. Some needed additional funds will flow in to increase exploration and drilling activity. It may also become obvious in political circles that there is a necessity to replace depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will move up faster than for drilling activity. Investment in facilities for EOR projects and other production enhancing technology will boost spending in this area. Outlays will increase 68.1% during the forecast period, moving up to $5.86 billion in 1996. Outer continental shelf (OCS) lease bonus payments will increase as the economics of the available offshore leases improve with the rising prices. The projection is for OCS bonus payments to rise to $950 million in 1996.

Spending on downstream facilities and other projects will not increase as rapidly, but spending will move up as higher prices make more funds available for investing. Outlays will increase 26.6% to $25.2 billion in 1996. This is an increase of $5.305 billion.

Spending on refining facilities is expected to move up during the forecast period. Refiners will be investing to upgrade facilities for reformulated gasoline production due to environmental concerns, for pollution cleanup, and possibly some expansion. Annual refining capital expenditures are expected to increase to $7.495 billion in 1996. This would be an increase of 29.4% over 1991. A recent study by a consulting firm indicated that almost all gasoline may have to be reformulated by the year 2000. They estimated that this would cost refiners an investment of $22 billion.

Investment in the petrochemical industry will concentrate on improving efficiency, reducing costs in the face of increasing foreign competition, and increased capacity as petrochemical demand grows with the economy. The petrochemical industry set record profits in 1988 and 1989, and sales were increasing markedly along with the growing economy. The growth has slowed but is expected to resume again during the forecast period. Spending for petrochemical facilities will move up to $4.29 billion in 1996, an increase of 31%. Total spending for refining and petrochemical operations together is projected to increase 30% to $11.785 billion in 1996.

Capital spending for marketing facilities is expected to continue to move up throughout most of the forecast period. Spending will slow slightly in 1992 when prices fall. The intense level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 27.3% to $3.245 billion in 1996.

Transport spending for pipelines, tankers, and trucks will increase 23% during the forecast period, moving up $955 million to $4.1 billion in 1996.

Spending by U.S. oil companies for mining and other energy activities is expected to move up moderately during the forecast period. A number of companies have sold or discontinued their mining and metals operations, but many are still investing in other energy. Outlays will increase

27.4% to $1,490 million in 1996.

In the exploration and production sector, some of the larger international companies are shifting a large proportion of their spending overseas. A sampling of spending plans for a group of U.S. companies show international expenditures will be up 22% in 1991 to $16.631 billion. Exploration, drilling, and production outlays are projected to be up 29.8% to $11.756 billion.

This is indicative of an expected shift to more investment in international activities. With lower cost, more profitable exploration and production activity possible overseas, U.S. international companies are diverting more of their investments to overseas operations than in past years. It has been possible for the companies to negotiate some attractive exploration agreements in some of the non-OPEC producing countries. Overseas downstream investments will not move up as rapidly. The worldwide industry already has some excess capacity in refining and petrochemicals, and new facilities in the Middle East have further added to the problem. Some investment could be shifted from U.S. domestic activities to the international scene, but the funds will be selectively invested in the most profitable sectors of the business.

Total spending by the worldwide petroleum industry is projected to move up in 1992 in anticipation of future profit improvement. Total spending is projected to be up 6.8%, an increase of $5.03 billion to $79.5 billion for 1992. Upstream spending is expected to move up 6.3% to $58.7 billion.

CAPITAL EXPENDITURES

KEYS TO THE FUTURE

1. Increased prices for crude oil, natural gas, and petroleum products coupled with increased demand will give a substantial boost to industry cash flow. Prices will fall in 1992 when production from Iraq and Kuwait reenters the market. However, spending will move up on the strength of increased demand. During the remainder of the forecast period, prices will climb along with increases in energy demand. Spending will move up to meet demand.

2. Exploration and drilling expenditures will move up faster than prices as the economics of drilling improve. Some outside money will flow back into the industry due to the improved profitability. Increases in natural gas prices and demand will give a substantial boost to E&P spending. Exploration and drilling spending will be 43.6% higher in 1996.

3. Increases in product demand will boost revenues in the refining and marketing sector. Increased cash flow and higher industry profits will lead to increased investment in the downstream sectors. New environmental regulations will require substantial investment for cleanup and compliance. Investment in refining and petrochemicals facilities will move up during the forecast period. Upgrading and some capacity additions will be required. Refining spending will be 29.4% higher in 1996. Petrochemical investment will be up 31%.

4. As demand for crude oil and natural gas move up during the forecast period, additional investment will be required in transportation equipment and pipelines. In this sector there will also be additional investment required because of environmental concerns. Transportation spending will be 23% higher in 1996.

5. Some U.S. international companies will shift a greater portion of their investment overseas, to take advantage of attractive international exploration and drilling opportunities. A stable level of prices in 1991 will also encourage these companies to boost spending overseas.

6. Higher prices and increased demand will boost worldwide oil industry spending substantially. It will continue to move up during the five years of the forecast period due to the increased worldwide energy requirements.during

THE OUTLOOK — CAPITAL EXPENDITURES

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES									
(million $)									
Exploration & drilling	13,064	12,920	13,305	14,460	15,535	17,045	18,550	+5,630	+43.6
Production	3,957	3,485	4,435	4,820	5,170	5,380	5,860	+2,375	+68.1
OCS lease bonues	663	700	750	800	850	900	950	+250	+35.7
Subtotal	**17,684**	**17,105**	**18,490**	**20,080**	**21,555**	**23,325**	**25,360**	**+8,255**	**+48.3**
Refining	4,402	5,790	6,170	6,510	6,850	7,205	7,495	+1,705	+29.4
Petrochemicals	3,125	3,275	3,390	3,600	3,835	4,125	4,290	+1,015	+31.0
Marketing	2,702	2,550	2,680	2,820	2,940	3,120	3,245	+695	+27.3
Pipelines	2,482	3,150	2,980	3,160	3,350	3,530	3,720	+570	+18.1
Other transportation	647	995	1,020	1,120	1,225	1,325	1,380	+385	+38.7
Mining and other energy	873	1,170	1,215	1,290	1,360	1,430	1,490	+320	+27.4
Miscellaneous	2,993	3,010	3,110	3,185	3,345	3,485	3,625	+615	+20.4
Subtotal	**17,224**	**19,940**	**20,565**	**21,685**	**22,905**	**24,220**	**25,245**	**+5,305**	**+26.6**
Total	**34,908**	**37,045**	**39,055**	**41,765**	**44,460**	**47,545**	**50,605**	**+13,560**	**+36.6**
Offshore spending	5,072	4,905	5,325	5,840	6,315	6,895	7,575	+2,670	+54.4
(million $) Exploration-Drilling-Production									
PRICES									
Crude oil (Av. U.S. wellhead-$/barrel)	20.03	16.80	16.10	15.20	16.60	17.50	18.90	+2.10	+12.5
Natural gas (Av. U.S. wellhead-$/mcf)	1.72	1.55	1.75	1.90	2.10	2.25	2.40	+0.85	+54.8
Motor gasoline (Av. all types-$/gallon)	1.22	1.25	1.22	1.20	1.25	1.30	1.35	+0.10	+8.0

OUTLOOK 2000 — CAPITAL EXPENDITURES

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES									
(million $)									
Exploration & drilling	13,064	17,045	24,830	+3,981	+7,785	+11,766	+30.5	+45.7	+90.1
Production	3,957	5,380	7,840	+1,423	+2,460	+3,883	+36.0	+45.7	+98.1
OCS lease bonues	663	900	1,150	+237	+250	+487	+35.7	+27.8	+73.5
Subtotal	**17,684**	**23,325**	**33,820**	**+5,641**	**+10,495**	**+16,136**	**+31.9**	**+45.0**	**+91.2**
Refining	4,402	7,205	9,130	+2,803	+1,925	+4,728	+63.7	+26.7	+107.4
Petrochemicals	3,125	4,125	5,890	+1,000	+1,765	+2,765	+32.0	+30.0	+88.5
Marketing	2,702	3,120	3,950	+418	+830	+1,248	+15.5	+26.6	+46.2
Pipelines	2,482	3,530	4,460	+1,048	+930	+1,978	+42.2	+26.3	+79.7
Other transportation	647	1,325	1,970	+678	+645	+1,323	+104.8	+48.7	+204.5
Mining and other energy	873	1,430	1,880	+557	+450	+1,007	+63.8	+31.5	+115.3
Miscellaneous	2,993	3,485	4,040	+492	+555	+1,047	+16.4	+15.9	+35.0
Subtotal	**17,224**	**24,220**	**31,320**	**+6,996**	**+7,100**	**+14,096**	**+40.6**	**+29.3**	**+81.8**
Total	**34,908**	**47,545**	**65,140**	**+12,637**	**+17,595**	**+30,232**	**+36.2**	**+37.0**	**+86.6**
Offshore spending	5,072	6,895	10,450	+1,823	+3,555	+5,378	+35.9	+51.6	+106.0
(million $) Exploration-Drilling-Production									
PRICES									
Crude oil (Av. U.S. wellhead-$/barrel)	20.03	17.50	23.75	−2.53	+6.25	+3.72	−12.6	+35.7	+18.6
Natural Gas (Av. U.S. wellhead-$/mcf)	1.72	2.25	3.05	+0.53	+0.80	+1.33	+30.8	+35.6	+77.3
Motor gasoline (Av. all types-$/gallon)	1.22	1.30	1.75	+0.08	+0.45	+0.53	+6.6	+34.6	+43.4

EXPLORATION, DRILLING, AND PRODUCTION

The outcome of the upheaval in the Middle East would have appeared to be somewhat favorable for the exploration and drilling segment of the U.S. oil and gas industry. After the dust had cleared, crude oil prices were at a level that was higher than it had been before the conflict. And what appeared more important for investment, prices were relatively stable for an extended period in 1991.

It has been known that higher crude oil prices would give a significant boost to exploration and drilling activity in the United States and throughout the producing areas of the world. But it was also felt that stable prices were an important factor in making investment decisions in exploration and production projects.

But stable crude oil prices for part of a year was not sufficient incentive for an increase in exploration and drilling activity in 1991. In fact, substantially lower natural gas prices in the United States have caused exploration and drilling activity to fall in the United States during 1991.

The exploration, drilling, and production sector of the U.S. oil and gas industry has been languishing in the trough of its most recent activity cycle for the last 5 to 6 years. Activity levels in exploration and drilling are at all time lows. But extreme cycles in activity seem to be the norm rather than the exception for the exploration and drilling sector of the U.S. oil and gas industry.

This sector of the industry has gone through some extreme cycles during its history. But none of the previous cycles was as pronounced as the present one. During this cycle exploration and drilling activity in the United States went through both a record high level of activity and hit a record low. And the time span from record high to record low was only a short period of 4.5 years.

Activity in this area of the industry has closely followed the price of crude oil and natural gas. The relationship between activity and price has been closer in this sector than in any other segment of the industry.

This segment of the industry has been amazingly adept at rapidly adjusting to shifts in economic conditions. At present it is difficult to determine if the industry is poised at the start of a new upward leg of another cycle or is caught in an extended trough. There have been modest signs of recovery, but there have also been indications of a continued recession in activity.

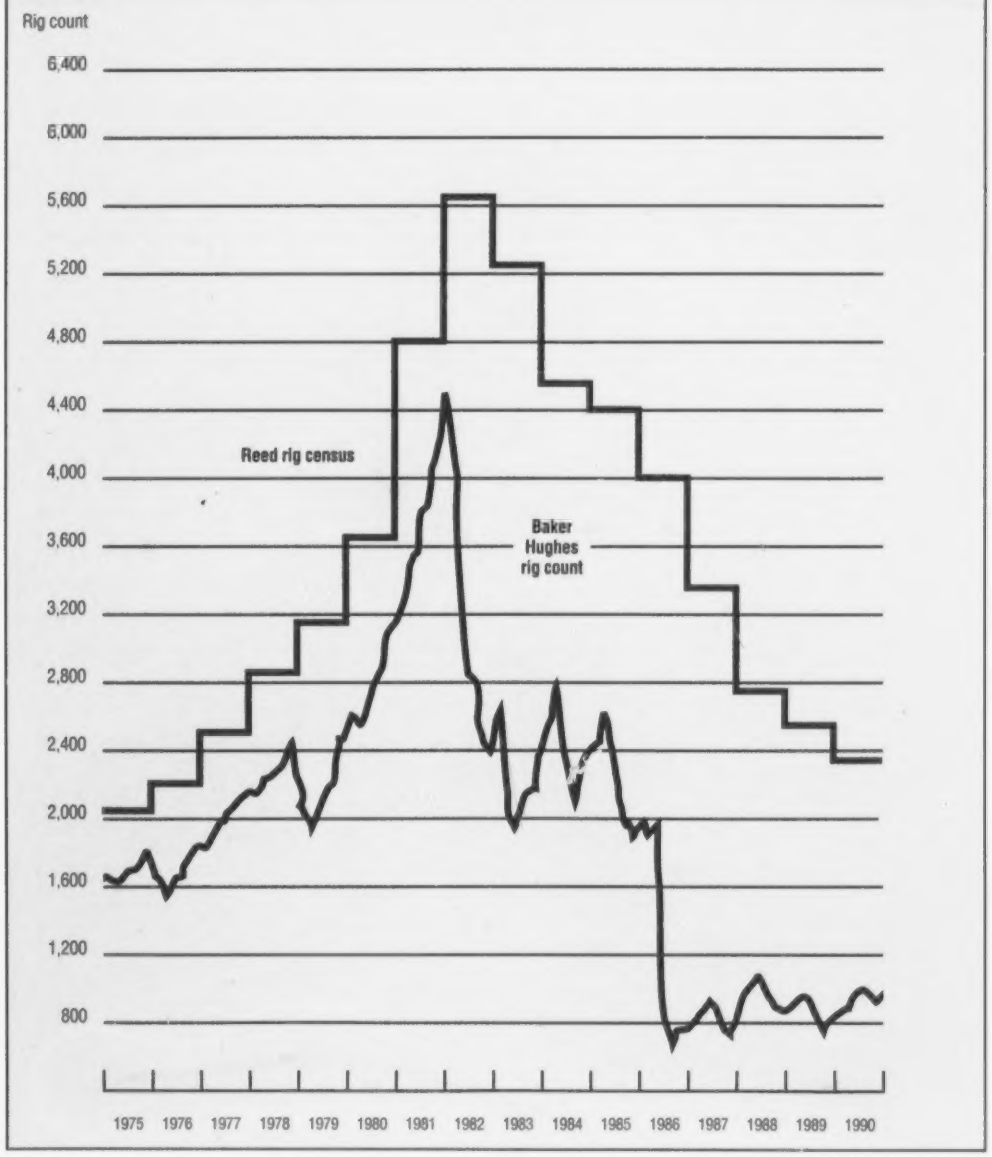
One thing that is certain is that crude oil and natural gas will be major energy sources for a long time into the future. And exploration and drilling are the only way to find new domestic reserves.

REVIEW

RIG ACTIVITY. The number of active rotary drilling rigs is a key indicator of activity in the upstream portion of the U.S. domestic oil and gas industry. Through the recent boom and bust cycle the number of active drilling rigs has closely followed the price of crude oil. And it appears that this close relationship will continue for the foreseeable future.

When the price of crude oil moved up rapidly between 1971 and 1981, the rig count followed. The number of active rotary drilling rigs increased from an annual average of 976 rigs in 1971 to a peak of an average of 3,970 rigs in 1981. This was an increase of 2,994 active rigs, 306.8%. The amount of domestic drilling activity quadrupled over that 11-year span. The record active rig count for any one week was reached the last week of December 1981, at 4,530 active rotary rigs. During that period the rig count was chasing the rapidly increasing price of oil. Back in 1971, the average U.S. wellhead price for crude oil was $3.39/bbl. This moved up sharply in the 1970s and reached a high of $34.70/bbl in March 1981. At that lofty price almost any producing well was considered economic and therefore drilling activity rapidly increased. Prices began to slip after March 1981. There was not an immediate response in rig activity since prices were still at a very high level. Starting in Jan-

THE RIG FLEET AND ACTIVITY



WELL COMPLETIONS, FOOTAGE, AND ACTIVE RIGS

	Active rigs	Total well completions*	Total footage*	Avg. ft. per well	Avg. wells per rig	Avg. ft. per rig
1974	1,471	33,037	153,776,399	4,655	22.46	104,539
1975	1,660	38,884	181,039,993	4,656	23.42	109,060
1976	1,656	40,940	187,289,586	4,575	24.72	113,098
1977	2,001	45,855	215,695,878	4,704	22.92	107,794
1978	2,259	50,061	238,386,248	4,762	22.16	105,527
1979	2,177	51,890	243,685,430	4,696	23.84	111,936
1980	2,910	69,486	311,444,837	4,482	23.88	107,026
1981	3,970	89,234	406,520,453	4,556	22.48	102,398
1982	3,105	83,889	375,382,919	4,475	27.02	120,896
1983	2,232	75,738	316,617,464	4,180	33.93	141,854
1984	2,428	84,983	368,796,000	4,340	35.00	151,893
1985	1,980	70,806	316,778,000	4,474	35.76	159,989
1986	964	39,015	177,641,000	4,553	40.47	184,275
1987	936	36,253	163,848,000	4,520	38.73	175,051
1988	936	32,301	154,941,000	4,797	34.51	165,535
1989	869	27,624	131,801,000	4,771	31.75	151,670
1990	1,010	29,385	144,978,000	4,934	29.15	143,543

*Excludes service and stratigraphic wells and core tests.

Source: American Petroleum Institute and Baker Hughes Inc.

uary 1982, the rig count finally followed prices, and the rig count fell precipitously. The active rig count fell for 10 consecutive months, hitting a 1982 low of 2,379 in October, and averaging 3,105 active rigs for the year. There was a slight seasonal upturn at the end of the year, but then the count continued its decline. The number of active rigs fell to 1,807 in April 1983. This was down 2,723 active rigs from the peak, a drop of 60.1% in rig activity. The annual average for 1983 was 2,232 active rigs, down 1,738 rigs from the annual average peak, a drop of 43.8%.

Prices seemed to stabilize at around $26/bbl in 1984. And as a result there was a slight upturn in rig activity in 1984. The rig count averaged 2,428 for the year. But the price of crude oil slid further in 1985, to $24/bbl. The rig count also fell, averaging 1,980 for the year, down 18.5% from the year before. The rig count that year was down 50% from the top year in 1981.

Excess worldwide production brought about a precipitous crash in crude prices in 1986. And this resulted in a sharp drop in the active rig count, falling to a record low. The rig count had averaged 1,950 active rigs in the month of December 1985. With the crude oil price in a "free fall," the rig count took a free fall, dropping to a record average monthly low of 686 active rigs in July 1986. The record weekly low was recorded July 14, 1986 at 663 rigs. From the record high in December 1981 this was a drop of 3,867 active rigs, 85.4% in 54 months. The year ended with the lowest annual average rig count since 1942—964 active rigs. In 1942 the count was depressed because manufacturing activities were focused almost solely on producing for the military effort.

Crude oil prices dipped below $10/bbl in 1986. The low point was July 1986 when the average wellhead price for U.S. crude oil hit $9.25/bbl. For the year, prices averaged $12.51/bbl, down 48.1% from the previous year and down 60.6% from the peak year.

The decline in crude oil prices was the main reason for the sharp drop in rig activity. But there were a couple of factors that contributed to the magnitude of the decline. Not only did prices begin to slide in 1981 but, by the next year, the long range outlook for oil prices had changed dramatically. During the expansion phase of the boom, projections called for oil prices to move up to $50/bbl and higher in the near future. And a lot of the investment was based on these price expectations. This outlook prevailed for some time even after prices had begun to fall.

Prices turned around in February and March 1981. The U.S. refiner acquisition cost of imported crude peaked in February 1981 at $39/bbl. Domestic refiner acquisition cost and wellhead price peaked in March 1981, at $36.97 and $34.70, respectively. Analysts were not immediately aware of the turn around or did not recognize it as a turning point. Aggregate price data prepared by the government was not immediately available to warn of the change in direction in crude oil prices. It often takes from three to five months for government agencies to collect, aggregate, and publish this information.

U.S. PRODUCING WELLS

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Well completions:									
Oil wells	40,182	38,286	44,088	36,581	18,842	16,441	13,608	10,338	11,514
Gas wells	17,167	12,727	14,989	12,925	8,168	8,114	8,403	9,005	9,796
Net abandonments:									
Oil wells	17,049	15,138	26,571	10,762	36,778	24,950	6,696	30,550	30,633
Gas wells	5,253	1,528	3,088	3,434	9,985	416	349	3,801	1,877
	22,302	**16,666**	**29,659**	**14,196**	**46,763**	**25,366**	**7,045**	**34,351**	**32,510**
Producing wells: (Dec. 31)									
Oil wells	580,142	603,290	620,807	646,626	628,690	620,181	627,093	606,881	587,762
Gas wells	210,753	221,952	233,853	243,344	241,527	249,225	257,279	262,483	270,402
	790,895	**825,242**	**854,660**	**889,970**	**870,217**	**869,406**	**884,372**	**869,364**	**858,164**

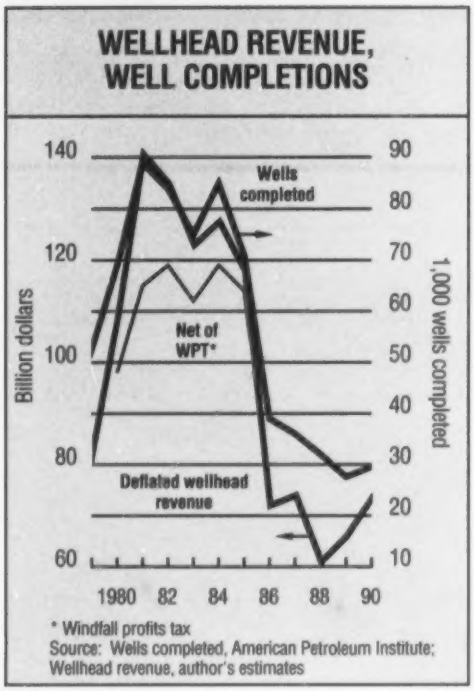
Source: API, abandonments calculated by author

At that early date, few analysts or investors picked up on the implications of the early 1981 drop in prices. Any leveling of prices was considered temporary or regional. At the prevailing prices, even though slightly lower, many projects were still very attractive. So the drilling boom continued throughout 1981 and into 1982, even as crude prices fell.

As prices continued the slide, prospects for any future appreciation of the value of crude oil evaporated, at least for the immediate future period that is used for making investment decisions. Therefore, outside investments in drilling activity declined. Part of the boom had been financed by speculative investing, which tends to chase the highest expected rate of return. With the drop in prices and a pessimistic outlook, much of that investment money fled from the petroleum industry.

Another reason for the rapid and extremely deep cut in drilling activity was the accumulation of debt by oil operators and producers. Expectations that crude oil prices would reach $50/bbl and continue to climb had stimulated the surge in drilling activity. With an industry consensus supporting this outlook for higher prices, investment funds flowed into the drilling industry, and banks actively sought investors in oil exploration projects. Funds were available and the analysis seemed to favor investment, even if it required substantial debt. Everyone wanted to drill as many prospects as possible as fast as possible, and many companies borrowed the needed funds and became burdened with debt. When prices fell, funds had to be diverted to handle the debt. The result was a sharper drop in activity than would have been otherwise warranted by the basic economics. Actually the economics of drilling improved during the 1982–1985 period. Drilling costs fell faster than crude prices during this period. But many companies were unable to take advantage of this because of the debt burden they had accumulated during the boom.

The rig count fell to a record monthly and weekly low in July 1986 and then rebounded slightly toward the end of that year. But the recovery was rather weak and rig activity has remained depressed ever since 1986. Crude prices also rebounded at the end of 1986 and remained at the higher level in 1987. But following the price crash in 1986, the industry investors were wary of the economics of future drilling prospects. Therefore drilling activity was very sluggish during the first half of 1987. Activity picked up during the second half of the year, but the increase was not sufficient to boost the average for the year, and it finished below 1986. The rig count ended the year with 1,162 active rigs, but an annual average of only 936. That established a new mod-



ern low for the annual average of rig activity.

The industry was optimistic that 1988 would show an improvement in rig activity. The year started out well, but OPEC production decisions caused the price to weaken later in the year. Therefore rig activity remained sluggish throughout the year. The average rig count for the year was the same as 1997 at 936.

Crude prices moved up again in 1989 but the skepticism had returned. Prices had collapsed in 1986 and 1988 and companies remained extremely reluctant to invest in new exploration and drilling activity. The rig count managed to finally move over 1,000 toward the end of the year. But the 1989 average for the year set another modern day low at 869 active rigs.

In 1990 average wellhead crude prices moved up again. The price jumped substantially after Iraq invaded Kuwait, and there was some expectations of a shortage of crude for the winter heating season. The average price of U.S. crude oil at the wellhead moved up to $20.03/bbl, the highest it had been since 1985. In addition, the average wellhead price for natural gas moved up slightly to $1.72/mcf, an increase of 1.8%. These price increases did help to stimulate a small increase in drilling activity. The average active rig count for the year moved up to 1,010, also the highest level since 1985.

There was some expectation that drilling activity would move up in 1991. However, low natural gas prices and expectations of low oil prices sometime in the near future seemed to stifle activity. The average active rig count through the first eight months of 1991 averaged only 917. It is now expected that the average for the year will fall to 940 active rigs, down 6.9% from 1990.

SEISMIC ACTIVITY. The level of seismic crew activity is one of the better leading indicators of future drilling activity in the United States. Movements in the level of seismic crew activity tend to lead drilling activity. However, like drilling, seismic activity is also very closely related to the price of crude oil and/or natural gas. Therefore, seismic activity also went through a very volatile period the past few years.

The seismic crew count moved up rapidly during the drilling boom period. The number of active crews started its climb in April 1976 at 238 crews. And it hit a peak of 744 crews in September 1981, three months prior to the peak in drilling activity. The downturn in seismic crew activity was one of the early warning signals of the coming downturn in drilling activity.

After hitting the peak, the number of active seismic crews fell steadily to 447 in March 1983. This was one month before the

DRILLING COSTS*

	Total wells†	Total footage† (1,000 ft)	Total expenditures ($1,000)	Avg. cost per well ($)	Avg. cost per foot ($)
1975	36,960	177,642	6,571,214	177,793	36.99
1976	38,941	184,418	7,461,680	191,615	40.46
1977	43,826	212,694	9,956,453	227,181	46.81
1978	46,655	230,619	13,061,090	279,950	56.64
1979	48,523	237,512	16,078,930	331,367	67.71
1980	62,011	296,031	22,800,356	367,682	77.03
1981	80,816	388,800	36,665,456	453,691	94.30
1982	76,652	362,618	39,428,119	514,378	108.73
1983	67,536	301,226	25,104,543	371,721	83.35
1984	77,210	350,589	25,206,219	326,463	71.90
1985	67,821	314,490	23,696,603	349,399	75.35
1986	37,173	176,290	13,552,403	364,577	76.88
1987	33,041	157,357	9,238,749	279,615	58.71
1988	29,741	150,218	10,549,522	354,713	70.23
1989	26,693	131,474	9,669,339	362,242	73.55

*From the Joint Association Survey. †Doesn't agree with other reported figures because based on survey.

TOTAL WELLHEAD REALIZATIONS AND REINVESTMENT

	Total wellhead revenues ($1,000)	Net of WPT* ($1,000)	(JAS) Total drilling expenditure ($1,000)	Investment ratio (%)
1967	12,274,468		2,299,178	18.7
1968	12,963,514		2,409,360	18.6
1969	13,882,295		2,610,671	18.8
1970	14,919,586		2,578,682	17.3
1971	15,778,480		2,371,492	15.0
1972	15,886,972		2,814,166	17.7
1973	17,951,977		3,074,532	17.1
1974	28,153,951		4,366,989	15.5
1975	32,061,121		6,571,214	20.5
1976	35,801,316		7,461,680	20.8
1977	41,615,676		9,956,453	23.9
1978	46,562,738		13,061,090	28.1
1979	63,164,966		16,078,930	25.5
1980	97,765,720	87,840,720	22,800,356	26.0
1981	138,947,637	113,003,637	36,665,457	32.4
1982	135,526,277	118,772,277	39,428,119	33.2
1983	124,592,334	113,924,334	25,104,543	22.0
1984	132,048,177	123,174,177	25,206,219	20.5
1985	122,047,638	118,047,638	23,696,603	20.1
1986	72,242,658	72,242,658	13,552,403	18.8
1987	75,848,725	75,848,725	9,238,749	12.2
1988	64,573,328	64,573,328	10,549,522	16.3
1989	74,746,602	74,746,602	9,669,339	12.9
1990E	85,488,148	85,488,148	10,410,100	12.2

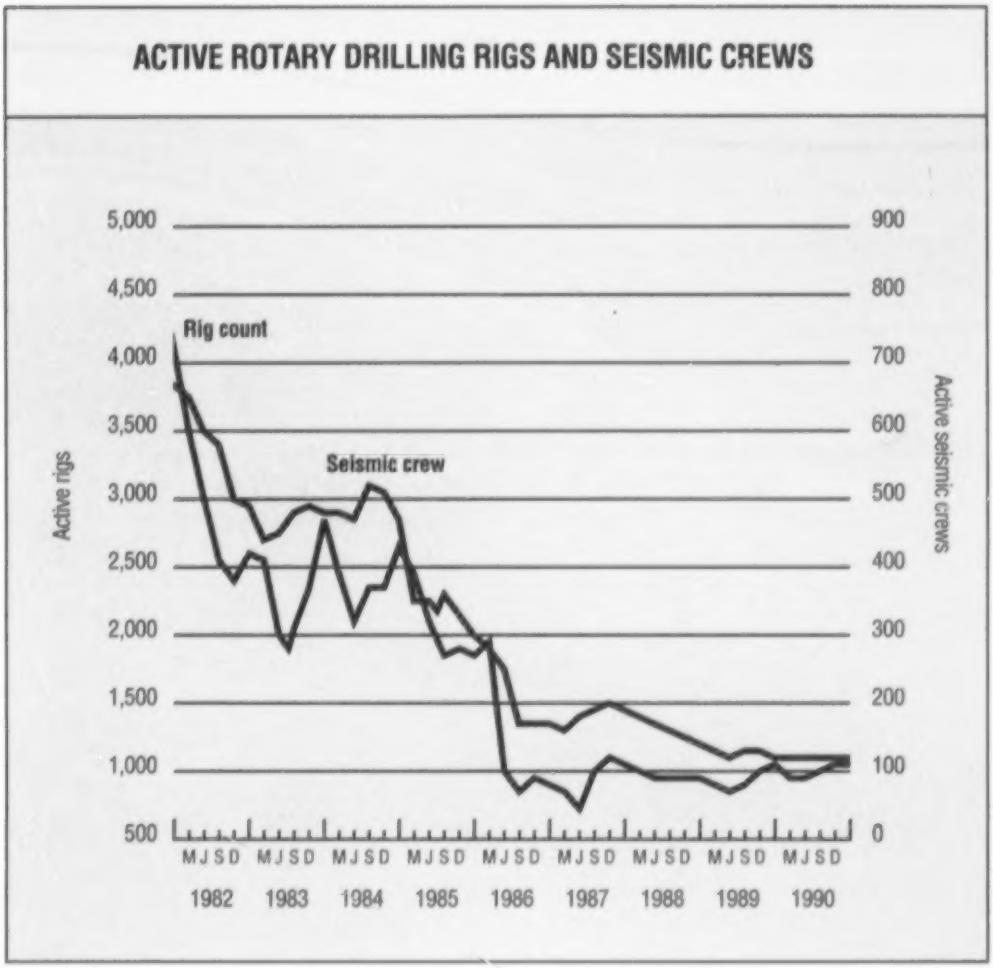
E-Estimate. *Windfall profit tax.

Source: 1970-1989 API, 1990 Author's estimate

rig count hit a temporary bottom at 1,846 average active rigs in April that year.

The number of active seismic crews moved up to 498 by October 1983, an increase of 11.4%. The rig count moved up 38% from April to November 1983. The seismic crew count fell slightly in early 1984, rose in mid-year, and then fell at year end. The seismic crew count fell sharply during the first half of 1985, leading the downturn in rig activity. It moved up marginally in the middle of 1985, but then started down again in August 1985, again leading the decline in drilling activity.

The seismic crew count fell sharply in 1986, and this continued into 1987. It hit a low of 150 in March 1987. This was down 79.8% from the peak in September 1981. The count moved up through the remainder of the year and reached 199 in December of 1987. It slipped a bit during the first half of 1988 and



then fell abruptly when prices dropped late in the year. The seismic crew count in December 1988 was down to 141, the lowest level in years.

This was not a good sign for drilling activity in 1989. The seismic crew count continued to slide in 1989 and fell as low as 124 in June. It moved up slightly during the last half of the year but finished the year at only 132 in December. The average for the year was 131.6. The seismic crew count remained at a depressed level in 1990, averaging 125 for year. The count has moved even lower in 1991 and has averaged only 111 crews for the first half of the year. There are few signs of a rapid resurgence of drilling activity in the United States.

WELL COMPLETIONS. The increase in drilling activity during the 1971–1981 period resulted in a substantial surge in U.S. well completions. Total well completions increased from 26,268 in 1971 to 89,234 in 1981, an

increase of 239.7%. This was a record high number of U.S. well completions and far surpassed any previous year. There were 69,486 wells completed in 1980, the previous high. Prior to those two years the previous record had been 57,182 wells back in 1956.

Moving along with the number of well completions, the total footage drilled moved up from 127.3 million feet in 1971 to 406.5 million feet in 1981, an increase of 219.5%.

Prices slipped, drilling activity dropped, and then well completions fell slowly during the next few years. They fell to 83,889 in 1982, 75,738 in 1983, rebounded to 85,359 in 1984, and were still at a high 70,806 in 1985.

During the period 1981–1985, 405,026 wells were completed, averaging 81,005 per year. This was by far the biggest boom period in the history of U.S. oil and gas industry drilling. This gigantic number of well completions was one of the major reasons why U.S. crude oil production was able to reverse its long-run decline and actually increase between 1981 and 1985. It is also the reason why U.S. reserves of oil and natural gas were sustained over this period.

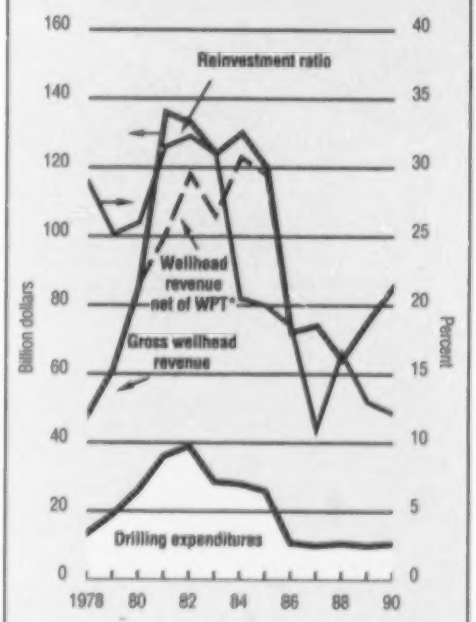
During the expansion period 1971 to 1981, well completions moved up 239.7%, but rig activity increased 306.7%. The reason for this difference in growth rates was a decline in rig efficiency. The drop in efficiency was due to the employment of less experienced less efficient crews on the new rigs. Well completions per active rotary rig fell from 26.9 wells in 1971 to 22.5 wells in 1981.

On the downswing the opposite was true. From the peak in 1981, well completions fell less than the active rotary rig count. Well completions and the footage drilled held up quite well when compared to the sharp drop in rotary rig activity.

There were 83,889 well completions in 1982, down 6% from 1981. The active rig count fell 21.8% in 1982. By 1985 the rig count had fallen 51% to 1,980, but well completions were down only 20.7% from the peak. Footage drilled also has not fallen as fast as the rig count. It has remained more closely aligned to the number of well completions. The total footage drilled peaked at 406.5 million feet in 1981. This had fallen to 316 million feet in 1985, down 22.1%.

One of the reasons for the smaller decline in well completions and footage drilled was an improvement in rig efficiency. This was the reverse of what was happening during

WELLHEAD REVENUE, DRILLING EXPENDITURES

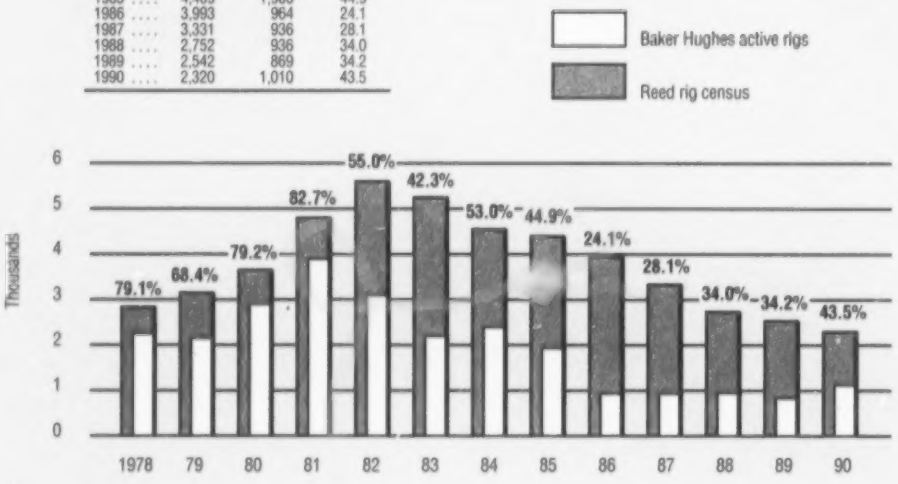


* Windfall profits tax
Source: 1978-1989, American Petroleum Institute
1990, Oil & Gas Journal

RIG UTILIZATION

RIG UTILIZATION

	Reed rotary rig census	Baker Hughes active rig count	& utilization rate
1978	2,851	2,259	79.1
1979	3,182	2,177	68.4
1980	3,672	2,910	79.2
1981	4,803	3,970	82.7
1982	5,644	3,105	55.0
1983	5,273	2,232	42.3
1984	4,580	2,428	53.0
1985	4,409	1,980	44.9
1986	3,993	964	24.1
1987	3,331	936	28.1
1988	2,752	936	34.0
1989	2,542	869	34.2
1990	2,320	1,010	43.5



Source: Reed Tool Co.; Baker Hughes Inc.

the upswing. The number of wells completed per active rig moved up to 35.7 in 1985. At that time rigs were working with more experienced crews. And also adding to rig efficiency was a switch to more development drilling. This is less time consuming than exploration drilling. During 1986 all of the indicators except rig efficiency collapsed. The active rig count fell another 51.3% to 964 rigs. And the number of well completions fell 44.8% to 39,118 wells. In that year the rig count was down 75.7% from the peak and well completions were down 56.2%. But the number of wells completed per active rotary rig climbed to 40.6.

In 1987 the rig count fell to 936 average rigs, down 2.9%. Well completions totaled 36,253, down 7.1%. And the average wells completed per rig fell to 38.7. This was the first slip in estimated aggregate rig efficiency since 1981.

The number of active rigs remained at an average of 936 in 1988. But the number of new well completions fell to 32,301. The number of wells completed per active rig fell to

INDEX OF COST OF DRILLING AND EQUIPPING WELLS

(1989 = 100)	Weight (%)	1984	1985	1986	1987	1988	1989	1990*
Payments to drilling contractors	30.7	135.7	137.1	116.6	87.4	104.9	100.0	85.3
Purchased items								
Road site preparation	4.4	89.2	90.7	92.4	94.7	96.8	100.0	104.0
Transportation	2.4	99.0	99.0	99.0	99.0	99.0	100.0	102.8
Fuel	0.6	146.3	139.4	84.4	95.7	86.0	100.0	117.2
Drilling mud and additives	5.8	99.4	100.0	100.0	100.0	100.0	100.0	100.0
Wellsite logging and/or monitoring system	1.1	95.4	95.4	95.4	83.4	84.8	100.0	118.2
All other physical tests	0.6	61.0	61.0	61.0	81.2	84.6	100.0	100.0
Logs and wireline evaluation services	3.7	124.4	111.8	83.8	90.8	96.9	100.0	100.0
Wellsite data services	0.1	NA	NA	NA	NA	100.0	100.0	100.0
Directional drilling services	1.6	86.7	85.7	85.7	85.7	90.2	100.0	103.3
Perforate	1.4	54.9	54.9	54.9	54.9	83.3	100.0	100.0
Formation treating	4.4	99.0	93.0	88.4	93.0	94.4	100.0	105.0
Cement and cementing services	4.8	97.8	90.7	84.6	88.8	95.4	100.0	105.0
Casing and tubing	13.7	77.8	76.9	71.6	76.9	93.4	100.0	108.5
Casing hardware	0.9	77.8	76.9	71.6	76.9	93.4	100.0	108.5
Special tool rentals	2.7	96.0	96.0	98.0	98.9	100.0	100.0	106.6
Drill bits and reamers	2.3	84.2	84.5	83.2	85.2	98.1	100.0	107.6
Wellhead equipment	1.8	97.2	100.9	101.0	99.0	99.0	100.0	99.5
Other equipment and supplies	3.0	94.3	95.1	93.5	94.1	97.7	100.0	103.0
Plugging	1.3	94.8	93.0	92.3	95.2	94.4	100.0	105.0
Supervision and overhead	5.6	86.8	89.7	93.9	92.5	94.9	100.0	103.0
All other expenditures	7.1	92.4	92.8	89.5	91.8	95.1	100.0	104.9
Sub-total purchased items	**70.2**	**93.1**	**94.6**	**95.5**	**95.8**	**103.6**	**100.0**	**93.1**
Total†	**100.0**	**87.0**	**89.7**	**92.2**	**83.2**	**105.4**	**100.0**	**95.5**

*Preliminary. †Weighted according to 1989 weights for all years.
Source: IPAA

34.5. In 1989 the rig count dipped to an average 869 and well completions fell to 27,624. Wells per active rig fell to 31.8.

In 1990 the active rig count rebounded to average 1,010. The estimated number of well completions moved up to 29,385. The number of wells completed per active rig fell again to 29.1 wells per rig.

There are several possible reasons for the drop in apparent efficiency: an increase in horizontal drilling which takes longer for well completion, an increase in deep well drilling in a search for larger reserves, an increase in gas well drilling (gas wells take longer to complete), a larger proportion of offshore drilling which also takes longer for completion.

The number of wells completed per rig is a very rough measure of rig efficiency. There appear to be wide variations between changes in the rig count and changes in the number of well completions. One of the major reasons for the disparity between rig count and well completions may be the lack of statistical data covering activity of all types of rigs. The Baker Hughes weekly survey of rig activity records active rotary rigs with a drilling depth capability greater than 2,500 feet. Many, if not most, of the more shallow wells are drilled with other types of rigs which are not counted in this weekly survey. Since shallow wells are far less costly, the drop in oil prices did not have as big an impact on shallow drilling. Therefore, a larger percentage of the more shallow drilling activity continued during the downturn in the drilling industry. The ratio of total wells drilled to rotary rig activity also includes the wells drilled with other types of rigs. This inflates the number of wells drilled per active rotary rig.

The average number of wells completed that are greater than 2,500 feet may be a better indicator of efficiency. Rotary rigs tend to be used for deeper drilling, and therefore an improvement in the number of these deeper

WELL COST AND OIL PRODUCTION

Year	Average cost per well ($)	Wellhead price of oil ($/bbl)	Barrels of oil to cover well cost
1970	94,885	3.18	29,838
1971	94,708	3.39	29,937
1972	106,424	3.39	31,394
1973	117,152	3.89	30,116
1974	138,718	6.74	20,581
1975	177,793	7.56	23,518
1976	191,615	8.19	23,396
1977	227,181	8.57	26,509
1978	279,950	9.00	31,106
1979	331,367	12.64	26,216
1980	367,682	21.59	17,030
1981	453,691	31.77	14,280
1982	514,378	28.52	18,036
1983	371,721	26.19	14,193
1984	326,463	25.88	12,614
1985	349,399	24.09	14,504
1986	364,577	12.51	29,143
1987	279,615	15.40	18,157
1988	354,713	12.58	28,197
1989	362,243	15.86	22,840
1990E	370,490	20.03	18,497

E-Estimate

Source: Department of Energy and API 1970-1989; Author's estimates 1990

wells drilled per rig is a more accurate efficiency indicator. Wells completed deeper than 2,500 feet per active drilling rig moved up from an average 16.7 during 1971–1981 to 18.2 in 1982. This indicator then increased to 21.7 in 1983, 23.4 in 1984, 24.1 in 1985, and 27.1 in 1986.

This measure of efficiency followed the other, and the number of wells drilled deeper than 2,500 feet per active rig fell to 26.3 in 1987, 24.6 in 1988, 22.7 in 1989, and 21.1 wells per active rig in 1990. There are a number of factors that influence rig efficiency. But it appears obvious from this rough indicator that rigs are presently employed more efficiently than in the expansion and boom years. But the changes in drilling objectives and methods are changing the meaning of this indicator.

Also of note is the fact that the average depth of wells fell rather sharply from 4,556 feet per well in 1981 to 4,180 feet per well in 1983. Part of the reason for the drop in average depth was a shift away from deep gas well drilling and a concentration on shallow oil well drilling.

The drop in demand for natural gas and the slowdown of the climb in natural gas prices led to the curtailment of a substantial amount of natural gas drilling. Between 1979 and 1983, demand for natural gas fell 17%. This led to the natural gas surplus and resulted in a decline in gas well drilling. This was particularly true for deep gas wells, below 10,000 feet. Close to 1,500 of the rigs that were idled were attributed to the decline in deep well drilling.

The average depth per well has moved up in the last couple of years reaching 4,520 feet per well in 1987, 4,797 feet per well in 1988, 4,771 feet per well in 1989, and 4,934 feet per well in 1990. This rise was due to a sharp drop in shallow well drilling (much of which had relatively poor reserve prospects), an increase in gas well drilling, and a surge in horizontal well drilling. The increase in horizontal well drilling changes the definition of this statistic. It is now footage drilled per well and not necessarily depth per well.

WELLHEAD REVENUES. To get a better perspective on what determines the level of exploration and drilling activity, it is essential to take a look at wellhead prices and wellhead revenues.

The close relationship between wellhead prices and rig activity has been documented several times. Between 1971 and 1973, the average wellhead price of oil moved up 123%, and the rig count increased 70.1%. From 1975 to 1981 the average wellhead price increased 320.2%, and the rig count moved up 139.2%.

During this expansion phase of the drilling cycle the average wellhead price of natural gas was also moving up rapidly. The price increased from $.22 per thousand cubic feet

TOTAL U.S. OPERATING OIL WELLS

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Flowing	38,060	36,065	32,994	36,104	37,665	35,148	32,870	32,500	31,953	29,486
Artificial lift	518,949	544,077	570,296	584,093	609,070	588,256	587,311	594,696	571,403	558,276
Total	557,009	580,142	603,290	620,197	646,735	623,404	620,181	627,196	603,356	587,762

Source: American Petroleum Institute

TOTAL U.S. SUPPLY OF TUBULAR GOODS

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Tubular goods (Thous. tons)											
Mill shipments	2,458	3,612	4,241	1,759	677	1,406	1,299	483	919	1,130	909
Less exports	−285	−133	−128	−67	−8	−12	−14	−36	−30	−74	−320
Plus imports	457	1,036	2,389	2,180	565	2,214	1,506	617	570	988	429
U.S. supply	2,630	4,515	6,502	3,872	1,234	3,608	2,791	1,064	1,459	2,044	1,018
Footage drilled (Thous. ft.)	243,685	311,445	406,520	375,706	317,996	368,796	316,778	177,641	163,848	158,883	137,492
Tons tubular goods Per thous. ft.	10.8	14.5	16.0	10.3	3.9	9.8	8.8	6.0	8.9	12.9	7.4

Source: IPAA

(mcf) in 1973 to $2.66/mcf in 1984. Between 1973 and 1982 the price increased 1,018%. This is an average annual increase of 31%. The natural gas price moved up an additional 5.3% in 1983 and 2.7% in 1984. These later price increases weren't sufficient to stop the slide in drilling activity, but they did provide some additional wellhead revenue to help support additional drilling.

The downturn in drilling activity started after 1981 and followed the fall in prices. Between 1981 and 1985, the average wellhead price of crude oil fell 24.2%, and the active rotary rig count fell 50%. And in 1986 the average wellhead price collapsed, falling 48.1%, and the active rig count fell 51.3%.

Adding additional downward pressure on rig activity during this period, the wellhead price of natural gas fell. This dragged the rig count down even more. The wellhead price of natural gas fell 6.6% in 1985 to $2.51/mcf. And then in 1986 it fell another 22.7% to $1.94/mcf. It continued down in 1987, falling to $1.67/mcf. The price in 1987 was down 37.2% from the peak in 1984.

The prices of crude oil and natural gas, coupled with the volume of production, determine the level of wellhead realizations or revenues flowing from production activities. This is also the pool of investment funds that supports a great deal of the future drilling activity. It is expected that a portion of this revenue will be reinvested in exploration and drilling. The total revenue from crude oil and natural gas production and the rate at which it is reinvested are key determinants of the level of drilling activity.

With rising oil and gas prices in the 1970s, total wellhead revenues moved up rapidly. Total U.S. wellhead realizations were $15,778 million in 1971. This moved up and peaked in 1981 at $138,947 million. This was also the year of peak oil prices and a year with a relatively high level of demand for natural gas. At that time the windfall profit tax (WPT) took a portion of the total revenues available. In 1981, net of this excise tax, total wellhead revenues were $113,004 million. Producers were generating 616.2% more revenue per year than they had been 10 years earlier; an

additional $97.2 billion was flowing to oil and gas producers, investors, royalty owners, and into state and federal excise taxes than 10 years earlier.

In addition to the high level of revenue available, the reinvestment ratio in 1981, at 32.4%, was the highest since 1970. The reinvestment ratio is the percentage of total wellhead revenues that are invested in drilling. Total drilling expenditures in 1981 were $36,665 million.

Total wellhead revenues available to the industry and the reinvestment ratio moved up even higher in 1982. Crude oil prices had started to slide in 1982, but they were still high. In addition, crude oil production moved up, and natural gas prices were up. Total gross wellhead revenues slipped to $135,526 million, but revenues net of the WPT moved up to $118,772 million. And the reinvestment ratio moved up to 33.2%. Total drilling expenditures moved up to a peak of $39,428 million.

As oil prices declined and natural gas demand fell, total wellhead realizations net of the WPT fell to $113,924 million in 1983. Some outside funds stopped flowing into the industry. Therefore, the high debt that the industry had accumulated during the peak years had to be financed. This reduced the reinvestment ratio sharply to 22% in 1983. Drilling expenditures fell to $25,105 million.

Total wellhead revenues moved up in 1984 to $123,174 million, net of WPT. Increased natural gas demand was the major reason for the increase. This was partially offset by lower crude oil prices. However, the reinvestment ratio fell to 20.5%. Total drilling outlays were an estimated $25,206 million in 1984. It should be noted that a portion of the drop in drilling expenditures in 1983 and 1984 was due to lower drilling costs. Therefore, the drilling activity level did not drop as much as outlays.

In 1985 the wellhead revenues available to the industry fell to $118,048 million, and the reinvestment ratio slid again to 20.1%. Drilling outlays dropped down to $23,697 million.

The sharp drop in wellhead revenues and drilling expenditures came with the collapse of prices in 1986. Wellhead revenues fell to $72,243 million, just above the level in 1979.

ROTARY RIG ACTIVITY BY STATES

	Average rig activity											
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Alabama	12.6	10.8	17.3	15.3	15.2	15.5	22.2	10.3	10.6	12.0	11.4	25.9
Alaska	13.5	13.8	23.5	21.6	13.8	14.1	20.1	12.8	8.5	12.1	10.9	11.7
Arizona	0.0	1.0	1.1	1.0	0.3	0.2	0.2	0.0	0.2	0.0	0.0	0.1
Arkansas	10.4	26.8	33.9	27.0	25.9	28.1	24.1	9.6	9.1	8.4	8.7	11.4
California	95.6	120.2	154.8	128.8	105.7	107.2	80.9	49.1	60.9	60.0	48.5	49.1
Land	85.7	104.7	133.7	106.2	83.4	89.2	69.1	43.8	54.6	52.9	42.8	45.1
Offshore	9.9	15.5	21.1	22.6	22.3	18.0	11.8	5.3	6.3	7.1	5.7	4.0
Colorado	40.2	61.1	81.6	60.3	52.2	53.9	50.0	24.3	24.8	28.7	26.9	30.2
Florida	5.3	4.1	7.8	4.6	4.4	3.6	6.7	2.2	2.8	1.4	1.8	2.0
Idaho	1.8	2.6	3.2	1.5	1.2	0.8	1.3	1.0	0.4	1.0	0.0	0.0
Illinois	13.1	25.4	42.9	75.5	60.2	41.5	28.6	5.6	3.4	3.9	4.8	4.0
Indiana	0.3	0.1	1.2	7.1	5.9	6.6	3.7	1.2	0.5	0.0	0.1	0.0
Kansas	66.0	120.2	196.2	157.4	124.1	127.6	92.0	46.8	48.5	40.0	42.6	46.8
Kentucky	0.4	1.7	5.3	9.5	8.4	8.1	6.2	2.5	2.0	5.1	5.3	7.8
Louisiana	347.0	427.4	455.6	343.1	283.6	309.9	283.5	142.1	134.7	163.2	139.6	150.9
North	34.5	54.9	58.0	39.9	29.4	30.3	24.7	11.3	11.4	13.9	16.1	18.5
Inland waters	62.1	76.6	83.2	59.2	47.1	51.4	43.7	20.2	22.9	25.0	17.1	20.5
South	112.3	156.4	160.3	107.8	81.9	96.1	85.8	41.8	35.4	36.7	34.7	36.0
Offshore	138.1	139.4	154.1	136.2	125.2	132.3	129.3	68.8	64.9	87.6	71.7	75.9
Maryland	0.5	0.2	0.6	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Michigan	25.1	30.7	36.5	31.4	29.1	34.1	33.7	24.0	21.8	19.5	16.8	12.7
Mississippi	40.2	57.6	71.5	41.6	32.8	32.4	31.0	15.3	13.1	17.5	16.7	12.5
Montana	32.9	49.2	81.4	36.2	23.9	36.0	22.9	9.7	8.5	7.8	5.3	5.3
Nebraska	9.2	14.3	15.0	9.4	9.0	9.1	6.5	3.1	5.2	2.9	1.3	2.2
Nevada	4.1	4.6	4.9	3.0	1.1	5.0	5.0	2.9	1.5	1.8	2.4	1.5
New Mexico	87.5	117.6	134.9	103.3	65.0	77.8	71.3	29.0	34.6	36.9	35.9	50.7
New York	8.7	7.0	11.6	15.1	10.2	8.9	5.0	2.2	2.0	1.1	0.5	1.1
North Dakota	56.5	83.4	118.8	69.4	42.5	50.9	38.5	13.3	14.1	14.5	14.6	19.9
Ohio	46.3	73.7	97.8	56.8	39.3	51.1	29.3	17.5	19.6	13.8	12.9	12.1
Oklahoma	246.7	397.3	698.4	621.5	285.5	319.2	252.3	141.2	136.1	125.3	121.8	125.3
Pennsylvania	28.9	29.0	38.6	32.6	22.0	35.5	29.8	17.9	17.4	18.7	17.3	15.0
Rhode Island offshore	4.0	2.1	2.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Dakota	1.4	1.9	2.2	1.5	1.0	2.2	1.8	0.6	0.4	0.7	0.8	0.3
Texas	770.2	987.7	1,317.0	989.6	797.5	850.1	680.7	310.9	293.0	280.3	263.4	348.8
Gulf Coast	141.3	210.5	305.2	169.0	133.9	138.1	102.3	44.5	42.4	36.8	38.2	46.7
Offshore & inland waters	50.3	72.1	74.5	88.3	56.2	60.1	51.8	21.7	19.8	25.4	22.8	22.7
North	122.4	147.2	170.7	138.1	125.0	99.6	87.3	36.5	23.8	28.5	23.6	25.3
Panhandle	48.1	50.8	66.6	66.2	48.3	49.9	37.5	16.0	16.8	15.1	11.2	10.4
East	107.0	119.8	163.9	115.7	102.2	102.1	77.4	45.4	36.2	37.6	51.2	47.2
West Central	109.4	140.4	191.6	139.8	102.7	124.5	82.5	41.7	44.8	43.9	42.3	102.3
West	191.7	247.1	344.5	272.5	229.2	276.9	241.9	105.1	109.3	93.0	74.1	94.3
Utah	28.9	42.4	69.2	39.8	36.8	45.3	28.8	11.1	7.4	6.1	5.3	5.2
W. Virginia	29.8	37.8	44.8	49.4	33.9	37.7	26.3	15.0	12.6	12.6	15.9	16.2
Wyoming	147.2	155.5	191.3	142.7	95.6	114.6	93.0	35.4	39.3	36.8	33.5	37.1
Others	2.9	3.3	8.6	6.5	5.0	3.2	4.9	6.9	3.1	4.4	3.6	4.3
Total U.S.	**2,177.2**	**2,910.3**	**3,969.5**	**3,104.9**	**2,232.3**	**2,428.2**	**1,980.0**	**963.5**	**935.9**	**936.3**	**868.6**	**1,010.1**
Canada land	334.6	396.4	258.6	195.0	189.5	242.8	300.3	174.8	179.3	194.4	126.6	136.8
Canada offshore	4.1	4.7	4.8	5.4	10.4	13.5	9.2	4.1	2.0	2.5	1.1	0.2
Grand total	**2,515.9**	**3,311.4**	**4,232.9**	**3,305.3**	**2,432.2**	**2,684.6**	**2,289.5**	**1,142.5**	**1,117.1**	**1,133.2**	**996.3**	**1,146.8**

Source: Baker Hughes Inc. Note: Columns may not add due to independent rounding.

RIG EFFICIENCY, WELLS DEEPER THAN 2,500 FT

Year	Rig count	Wells	Footage (Million)	Wells/ rig	Footage/ rig	Ft/well (Avg. depth)
1970	1,028	20,146	127.8	19.6	124,364	6,346
1971	976	18,226	116.4	18.7	119,260	6,386
1972	1,107	19,990	127.6	18.1	115,270	6,383
1973	1,194	20,464	129.1	17.1	108,120	6,309
1974	1,471	22,736	139.3	15.5	94,700	6,127
1975	1,660	27,140	164.4	16.3	99,040	6,057
1976	1,656	28,003	168.7	16.9	101,750	6,024
1977	2,001	32,803	196.8	16.4	98,350	5,999
1978	2,259	36,149	218.5	16.0	96,720	6,044
1979	2,177	36,096	221.1	16.5	101,560	6,125
1980	2,910	46,903	279.7	16.1	96,120	5,963
1981	3,970	62,009	368.8	15.6	92,800	5,948
1982	3,105	56,490	338.6	18.2	109,043	5,994
1983	2,232	48,357	280.7	21.7	125,775	5,805
1984	2,428	56,992	331.7	23.5	136,598	5,819
1985	1,980	47,881	285.9	24.2	144,383	5,971
1986	964	26,338	160.6	27.3	166,558	6,096
1987	936	24,623	148.3	26.3	158,422	6,022
1988	936	23,011	142.4	24.6	152,141	6,189
1989	869	19,825	121.5	22.8	139,814	6,129
1990	1,010	20,749	128.1	20.5	126,811	6,173

Source: Baker Hughes Inc.; American Petroleum Institute

And the reinvestment ratio plummeted to 18.8%. Drilling expenditures fell to the lowest level since 1978, at an estimated $13,552 million.

Wellhead revenues increased in 1987 due to a partial rebound in crude prices. Revenues moved up to $75,849 million. But a pessimistic outlook still prevailed with respect to drilling. The reinvestment ratio fell to 12.2%, and drilling outlays dipped to $9,239 million. The reinvestment ratio was one of the lowest on record, and drilling expenditures were the lowest since 1977.

Wellhead revenues continued the fall in 1988 due to the drop in crude oil prices. They dipped to $67,574 million, about on par with the $63,165 million in 1979. The reinvestment ratio moved up to 15.6% and drilling expenditures to $10,550 million. Wellhead revenues for 1989 increased to an estimated $74,540 million. The reinvestment ratio fell again to about 13.5%, and drilling spending dropped to an estimated $10,038 million.

In 1990 the spurt in crude oil prices at the end of the year boosted wellhead revenues, and they moved up 14.7% to $85,489 million. However, the reinvestment ratio fell again to 12.7% as drilling outlays moved up only 8.5% to $10,887 million.

DRILLING COSTS. Increased drilling activity boosted expenditures substantially during the boom years. However a large part of what was being spent on drilling activity during the boom years was a result of inflation in the cost of drilling a well. According to the Joint Association Survey of Drilling Costs, the average cost of drilling a well increased from $117,152 in 1973 to $514,378 in 1982. This was the record high for the average well cost.

The cost of drilling has fallen sharply since the peak of the drilling boom in 1981–1982. In 1983 the average cost per well fell sharply to $371,721, a drop of 27.7%. The cost continued to slide in 1984 with the average well cost falling to $326,463, down 36.5% from the peak.

The sharp drop in well costs was primarily due to competition in the drilling service and supply industry, brought on by the excess capacity and excess inventory that accompanied the drilling decline. Drilling contractors, as well as equipment and service companies, came away from the boom period with huge excess inventories and production capacities. Prices were slashed in an effort to reduce inventories and use idle capacity.

The average cost of a well moved up slightly to $349,399 in 1985 and $364,577 in 1986. But these increases did not reflect a true increase in drilling costs. A greater proportion of high cost offshore wells were drilled, and this increased the average cost estimates.

The average well cost fell to $279,615 in 1987. This sharp drop was due to a 21% decrease in offshore wells drilled. The cost per well moved back up in 1988 to $354,713/well. The cost moved up again in 1989 to $362,243/well drilled.

As stated, one of the reasons for the sharp drop in drilling costs was the intense competition in the industry due to the excess capacity. An indicator of excess capacity is the

rig utilization rate. The size of the rig fleet moved up with oil prices, increasing from 1,767 rigs in 1973 to 5,644 rigs in 1982. Based on the annual average number of rotary rigs running, the rig utilization rate moved up from 52.5% in 1971 to 81.9% in 1975. The rate stayed in the 68% to 80% range from 1976–1980 as the fleet size grew along with the number of active rigs.

The utilization rate hit 82.7% in 1981 as rig activity moved up faster than rig construction. The rig fleet was still growing in 1982 as rig activity fell, and the utilization rate plummeted to 55%. The rig fleet was reduced to 5,273 in 1983, but activity fell faster, and the utilization rate dropped to 42.3%. The total rig fleet was cut again to 4,580 in 1984, and the utilization rate moved up to 53%. In 1985 the rig fleet still stood at 4,409, but the number of active rigs fell to 1,986, resulting in a utilization rate of 44.9%.

But the worst wasn't over and competition really intensified in 1986. The rig fleet fell to 3,993, but the rig count plummeted to only 964. This resulted in a utilization rate of only 24.1%. In 1987 the fleet fell to 3,331 available rigs. The active rig count was 936, and the utilization rate moved up slightly to 28.1%. The rig fleet was further reduced to 2,752 in 1988. With 936 active rigs, the utilization rate moved up to 34%.

The rig fleet continued to slip in 1989, falling to 2,542 available rigs. With the active rig count averaging only 869, the utilization rate only moved up to 34.2%. In 1990 the active rig count jumped to 1,010, and the size of the rig fleet slipped again to 2,320. This boosted the utilization rate up to 43.5% in 1990.

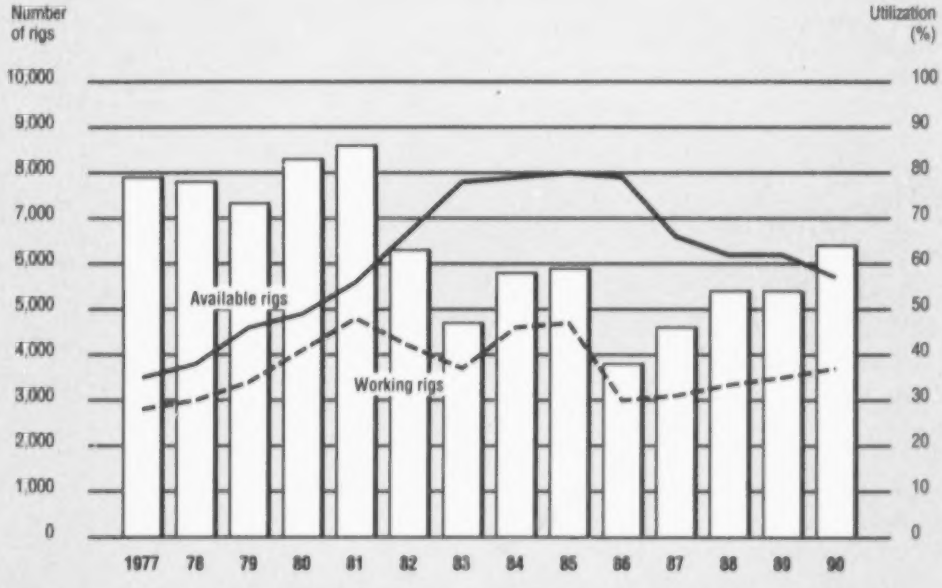
One of the ironies of part of the depression period in the domestic oil industry is that with declining drilling costs offsetting the drop in oil prices, the economics of drilling activity improved slightly between 1982 and 1985. The cost of drilling and equipping a well in 1985 was down 32.1% from the peak. In comparison, the average wellhead price of crude in 1985 was $24.09/bbl, down 24.2% from the peak. The profit margin had

RECORD HIGH AND LOW
Rotary rigs running — by States

State	Rig count 12-28-81	Rig count 7-14-86	Change 86-81	% change 86/81
Alabama-Land	20	3	– 17	– 85.0
Alabama-Offshore	3	2	– 1	– 33.3
Total Alabama	23	5	– 18	– 78.3
Alaska-Land	27	11	– 16	– 59.3
Alaska-Offshore	0	1	1	—
Total Alaska	27	12	– 15	– 55.6
Arkansas	42	7	– 35	– 83.3
California-Land	151	35	– 116	– 76.8
California-Offshore	25	2	– 23	– 92.0
Total California	176	37	– 139	– 79.0
Colorado	93	10	– 83	– 89.2
Florida-Land	4	1	– 3	– 75.0
Florida-Offshore	1	0	– 1	– 100.0
Total Florida	5	1	– 4	– 80.0
Georgia	0	1	1	—
Hawaii	1	0	– 1	– 100.0
Idaho	3	1	– 2	– 66.7
Illinois	105	5	– 100	– 95.2
Indiana	8	1	– 7	– 87.5
Kansas	214	33	– 181	– 84.6
Kentucky	15	3	– 12	– 80.0
N. Louisiana	54	8	– 46	– 85.2
S. Louisiana-Inl Water	87	13	– 74	– 85.1
S. Louisiana-Land	175	38	– 137	– 78.3
S. Louisiana-Offshore	168	44	– 124	– 73.8
Total Louisiana	484	103	– 381	– 78.7
Michigan	40	16	– 24	– 60.0
Mississippi	79	13	– 66	– 83.5
Montana	73	2	– 71	– 97.3
Nebraska	18	2	– 16	– 88.9
Nevada	2	2	0	—
New Mexico	160	11	– 149	– 93.1
New York	21	2	– 19	– 90.5
N. Dakota	123	10	– 113	– 91.9
Ohio	94	15	– 79	– 84.0
Oklahoma	871	99	– 772	– 88.6
Pennsylvania	38	15	– 23	– 60.5
Rhode Island—Offshore	3	0	– 3	– 100.0
S. Dakota	1	0	– 1	– 100.0
Tennessee	1	0	– 1	– 100.0
Texas-Offshore	78	15	– 63	– 80.8
Texas-Inl Water	0	1	1	—
District 1	38	4	– 34	– 89.5
District 2	122	11	– 111	– 91.0
District 3	220	22	– 198	– 90.0
District 4	133	26	– 107	– 80.5
District 5	32	9	– 23	– 71.9
District 6	144	18	– 126	– 87.5
District 7B	88	14	– 74	– 84.1
District 7C	99	9	– 90	– 90.9
District 8	206	30	– 176	– 85.4
District 8A	97	25	– 72	– 74.2
District 9	103	16	– 87	– 84.5
District 10	91	11	– 80	– 87.9
Total Texas	1,451	211	– 1,240	– 85.5
Utah	60	6	– 54	– 90.0
Virginia	3	6	3	100.0
Washington	3	0	– 3	– 100.0
W. Virginia	65	13	– 52	– 80.0
Wyoming	228	21	– 207	– 90.8
Total United States	**4,530**	**663**	**– 3,867**	**– 85.4**
Canada	262	68	– 194	– 74.0
Canada-Offshore	5	6	1	20.0
Grand Total	**4,797**	**737**	**– 4,060**	**– 84.6**

Source: Baker Hughes Inc.

U.S. WELL SERVICE RIG UTILITY



	1977	78	79	80	81	82	83	84	85	86	87	88	89	90
Available	3,556	3,837	4,681	4,937	5,616	6,730	7,861	7,988	8,007	7,958	6,646	6,245	6,247	5,742
Working	2,827	2,989	3,399	4,089	4,850	4,248	3,732	4,666	4,716	3,037	3,060	3,341	3,391	3,658
Utilization rate	79%	78%	73%	83%	86%	63%	47%	58%	59%	38%	46%	54%	54%	64%

Source: Well Servicing

improved relative to the profit margin at the height of the drilling boom.

However, that improvement was lost in 1986 when the wellhead price fell to $12.51/bbl. The 1986 price was down 60.6% from the peak while estimated well costs were down only 30% from the peak. There was a slight improvement in 1987 when the average price moved up to $15.41/bbl. But this was lost again in 1988 when prices fell back to an average $12.58/bbl. Prices moved up in 1989 but so did well costs. Therefore, the economics did not improve substantially.

Another way of illustrating the economics is by comparing the volume of oil required to cover the average cost of a well. Between 1970 and 1979, the number of barrels of oil that needed to be produced, to cover the average cost of a well, ranged from a low of 20,581 to a high of 31,394. This fell to 14,193 barrels in 1983 and only 12,614 barrels in 1984. When well costs moved up in 1985, this went up to 14,504 barrels. When prices collapsed in 1986, the volume of oil required to cover well costs jumped to 29,143 barrels. With an

increase in crude oil prices in 1987, it improved, falling to only 18,157 barrels. But with crude oil prices down again in 1988, it jumped to 28,197 barrels. Prices moved up in 1989, and the equivalent value fell to 22,840 barrels. This volatility makes drilling decisions very difficult.

PRODUCING WELLS. With the surge in well completions, the total number of producing wells in the United States moved up sharply. It reached an estimated 889,970 by year end 1985. In addition to new well completions, the higher oil and gas prices helped lengthen the life of old wells and slowed abandonments.

But when prices plummeted in 1986, the number of abandonments increased sharply. In 1986 the number of abandoned wells exceeded the number of well completions. The total number of producing wells fell to 870,217.

The number of producing oil wells dropped from 646,626 in 1985 to 628,690 at the end of 1986. The number of producing gas wells fell from 243,344 wells to 241,527.

Oil well abandonments exceeded completions again in 1987. Therefore, the number of producing oil wells fell to 620,181. There was a slight increase in the number of producing gas wells to 249,225. The total number of producing oil and gas wells slipped to 869,406. Abandonments slowed in 1988. Completions exceeded abandonments, and the total number of producing wells increased to 879,591. Producing oil wells moved up to 623,587, and gas wells moved up to 256,004.

It appears that abandonments lag prices a bit. Oil prices fell sharply again in 1988, and abandonments jumped up in 1989. Oil well abandonments moved up to 31,345, far outnumbering completions of 11,123. Therefore the number of producing oil wells fell to 606,881. The number of producing gas wells continued to move up, increasing to 262,483.

OUTLOOK

For the first time in many years crude oil prices have remained relatively stable for an extended period of time. The conflict in the Middle East in 1990 and early 1991 eliminated a large percentage of the excess production capacity in the world. That also eliminated the threat of major overproduction and reduced the threat of renewed downward pressure on prices.

The crude prices have stabilized at a level that is higher than they were in the months prior to the invasion. And it was felt that price stability was one of the major factors needed to stimulate upstream activity.

However, there are other factors that also enter into the decision making process. Of equal importance to many producers is the price of natural gas. Natural gas prices have not followed crude oil prices. Natural gas prices fell sharply in 1991 and remained at depressed levels for an extended period. This put a damper on plans to step up drilling activity in the United States in 1991.

In addition, the oil price level is probably not high enough to stimulate a great deal of activity. The stable price level makes economic evaluation easier, but the modest increase in the price level does not mean a substantial improvement in the economics.

Even of more importance is the fact that there is a lot of apprehension about the price level and the probability that the market will support this price for an extended period. There is a general feeling that prices will slide when production from Iraq and Kuwait reenter the market and when some of the announced

production expansion plans are completed.

During the past several years volatility in crude oil prices introduced a great deal of uncertainty into the upstream sector of the oil and gas industry. The outcome of the conflict in the Middle East reduced some of the political uncertainty and volatility, but it did not remove all of the price uncertainty. This uncertainty has made it very difficult to predict what will happen to domestic U.S. exploration and drilling during the next couple of years.

The OPEC decisions on production level had been determining the price level in recent years. And it has been difficult to predict what the OPEC countries would do concerning production quotas and output. With the reduction in capacity, it is now easier for OPEC to set a production level that will come close to balancing the market. The loss of production from Iraq and Kuwait has dried up most of the OPEC excess capacity.

However it does appear that in the near future OPEC will again be determining the crude oil price level by the setting of production targets. And it also appears that OPEC will have to manage a substantial excess production capacity.

The upstream sector will not be getting a major boost from crude oil prices. However it does appear that it will be getting a boost from increased demand for both crude oil and natural gas. And it will get a boost from improved natural gas prices.

The last few years of U.S. drilling activity have been at historically low levels. It now looks like this may be the bottom of the cycle, and the most probable outlook is for increased activity during the forecast period, 1992–1996.

In the early part of the forecast period, substantial additional crude oil capacity will come on stream. The additional capacity will tend to reduce prices. However it is felt that OPEC will be able to manage production well enough to prevent a complete collapse of crude oil prices. Over the longer run the decisions of OPEC will again be a key to prices and the level of activity. The main objective of most of the OPEC countries is to maximize revenue. Therefore it is doubtful in the long run that the OPEC countries want prices much below $18–20/bbl. They have been shown on several occasions that revenues will improve with a little production discipline and higher prices. In addition the increased demand for crude oil to fuel worldwide economic growth will utilize some of the new capacity.

The biggest boost to U.S. wellhead revenues will come from increased demand for natural gas and from an increase in natural gas prices. Renewed economic growth in the United States will mean an increase in demand for electricity and fuel for industrial activity. The new environmental concerns and regulations will result in the industrial and utility sectors looking to natural gas to meet the increase in their energy needs.

A boost in wellhead revenues and an increase in demand for energy, crude oil, and natural gas should result in an increase in exploration and drilling activity during the forecast period.

Base Scenario — Crude prices will fall in 1991 because they will not receive the crisis premium that elevated prices at the end of 1990. The average wellhead price of U.S. crude increased 26.3% in 1990 to an estimated $20.03/bbl, due to the jump in prices in the latter part of the year. Crude prices in 1991 are expected to average $16.80/bbl, down from 1990 but up 5.9% above 1989 and 33.5% above 1988. These increase should give some boost to exploration and production activity.

Crude prices are expected to slip slightly in 1992 and 1993. Worldwide crude production capacity is projected to move up

substantially during those two years. Capacity increases will come from expansion plans announced by several major producing/exporting countries and from the return of production from Iraq and Kuwait. This additional capacity will revive the OPEC excess capacity and make it more difficult for OPEC to manage production and balance the market. It is expected that the excess capacity will put downward pressure on prices and result in lower wellhead prices worldwide. However it is felt that OPEC may have better success in managing production because some of the radical producers have lost influence. In addition, it is expected that worldwide demand for crude oil will be moving up along with increased economic activity, and this will use up some of the additional capacity quickly.

The average wellhead price of U.S. crude oil is expected to fall to $16.10/bbl in 1992 and $15.20/bbl in 1993. As demand increases, prices will then move up, increasing to $18.90/bbl by the end of the forecast period, 1996.

The average wellhead price of natural gas will not follow the path of crude prices. Gas prices are projected to move up steadily throughout the forecast period to an average of $2.40/mcf in 1996, an increase of 54.8% from the depressed level of 1991. Prices are expected to move up due to increased energy demand that will accompany the increase in economic activity. In addition, natural gas will be in demand during the forecast period because it is a clean burning fuel. In order to meet the new more stringent clean air and other environmental requirements, utilities and industry will be turning to natural gas.

Mainly as a result of the drop in crude oil and natural gas prices in 1991, domestic wellhead revenues will fall substantially, down 14.4% to $73.218 billion. A drop in crude production and domestic natural gas production will contribute to the decline also.

Wellhead revenues will improve slightly in 1992 on the strength of higher natural gas prices and volumes. Revenues will move up 1.4% to $74.221 billion in 1992.

Crude oil prices and production are expected to continue to slump in 1993. The impact on wellhead revenues will be almost entirely offset by increases in natural gas revenues and production. Wellhead revenues are expected to fall 0.6% to $73.804 billion in 1993.

Even with the drop in wellhead revenues in 1992 and 1993, there is expected to be a slight improvement in exploration and drilling activity. The increased demand and higher prices for natural gas will be the major stimulant. But in addition, crude oil prices will be high enough to sustain some activity. The average rig count is projected to move up to average 1,000 in 1992 and 1,040 in 1993. Well completions are projected to move up from 28,490 in 1991 to 30,190 in 1992 and 31,390 in 1993. Spending on drilling activity is projected to move up from $10.766 billion in 1991 to $11.805 billion in 1992 and $12.83 billion in 1993. The reinvestment ratio is at a very low level and is expected to move up due to the improved outlook for the oil and gas industry.

Wellhead revenues are projected to move up during the remainder of the forecast period. They will be boosted mainly by increased natural gas and crude oil prices. Increased natural gas productionalso will help push up revenues. However, crude oil production in the United States is expected to slide throughout the forecast period. Wellhead revenues are expected to increase to $91.139 billion in 1996.

The increase in wellhead revenues and the favorable outlook for the industry is expected to lead to increased outlays for drilling activity and increased drilling activity. However, there will not be a boom in drilling activity. A lot of the exploration money is now

being spent on project evaluation. The attempt is to minimize the economic risk of drilling by careful and thorough evaluation prior to drilling.

The active rotary rig count is projected to move up to 1,200 in 1996. Well completions are projected to move up to 35,800 in 1996. Drilling expenditures will increase to $16.46 billion at the end of the forecast period. The reinvestment ratio is expected to move up to 18.1% in 1996.

There are some general trends in activity that are expected to show up during the forecast period. There will be an improvement in the cash flow into the upstream sector later in the forecast period. This is due to the improvement in prices and wellhead revenues. Some renewed optimism concerning the future of the natural gas and oil exploration and production business is expected to result in an increase in the reinvestment ratio. Increased profitability, resolution of debt problems, and an increase in outside investment money will boost the reinvestment ratio from 14.7% in 1991 to 18.1% by 1996.

The combination of higher wellhead revenues and an increased reinvestment ratio will result in higher drilling expenditures. This will result in a higher number of active rotary rigs and more well completions. These latter indicators will not increase as rapidly as total spending because there will be an increase in average well costs and a shift to more costly drilling. There will be an increase in natural gas well drilling and horizontal drilling during the forecast period. There will be a steady search for more economically attractive reservoirs and more efficient ways to drill.

The rough measures of drilling rotary rig efficiency are expected to show little change during the forecast period. There will be a shift to deeper wells, natural gas wells, horizontal wells, and more exploratory work. All of these wells take longer to complete. These changes are expected to be offset by gains in operational efficiency.

The economics of oil well drilling are not expected to improve due to an increase in crude prices. Well costs are expected to move up faster than prices. But the economics of gas well drilling should improve. In this case prices are expected to move up faster than well costs.

The number of well abandonments are expected to decline slowly throughout the forecast period. With increased prices, producers will be able to maintain marginal wells for a longer period. The total number of producing wells will increase but only marginally.

EXPLORATION, DRILLING, PRODUCTION

KEYS TO THE FUTURE

1. Crude oil prices will fall slightly during the initial years of the forecast period. Crude oil prices in 1991 have benefitted from the removal of some of the worldwide excess production capacity. Additions to capacity in some of the major producing countries and the resumption of crude production by Kuwait and Iraq will create excess capacity in the early forecast years. The growth in demand for energy will boost demand for crude oil and natural gas during the forecast period. This will result in a rise in natural gas prices throughout the period and an increase in crude prices in the later years, 1993–1996.

2. Wellhead revenues fell sharply in 1991 due to lower oil and natural gas prices and lower production levels. Wellhead revenues will remain at the 1991 level through 1993 as falling crude oil prices and production will offset rising natural gas prices and production. For the remainder of the forecast period, increased crude and natural gas prices will couple with increased natural gas production to boost wellhead revenues. The increase will be partially offset by sliding U.S. crude production.

3. Increased wellhead revenues and higher prices will boost investor interest and confidence in the oil business. The reinvestment ratio will move up throughout the forecast period, making more money available for drilling. The ratio will move up to 18.1% in 1996 from 14.7% in 1991.

4. Drilling expenditures will move up in 1992 even though crude oil prices will slip. Higher natural gas prices and increased domestic output will support wellhead revenues. Drilling outlays will continue to move up in 1993 on the strength of stronger natural gas prices and volumes along with renewed interest in the industry. During the remainder of the forecast period, drilling spending will be boosted by increased revenues and the higher rate of reinvestment. The improved picture for prices will encourage more exploration and drilling activity.

5. The increase in drilling outlays will boost the rig count, the number of well completions, and the total footage drilled. The rig count will increase modestly to 1,000 active rigs in 1992. The rate of increase will be slow during the forecast period as increased investment is directed to evaluation rather than drilling. The rig count will move up to 1,200 in 1996.

6. Well costs will move up faster than crude prices but not as fast as natural gas prices. However, a portion of the increase in well costs will be due to the advanced evaluation technology available. Therefore the economics of drilling are expected to improve due to lower dry hole costs and improved rates of production.

THE OUTLOOK — EXPLORATION, DRILLING, PRODUCTION

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
DRILLING ACTIVITY-U.S.									
Active drilling rigs	1,010	940	1,000	1,040	1,080	1,150	1,200	+260	+27.7
Well completions	29,385	28,490	30,190	31,390	32,430	34,380	35,800	+7,310	+25.7
Footage drilled (thousands)	144,978	141,025	149,440	155,380	160,850	170,525	177,925	+36,900	+26.2
Average well depth	4,934	4,950	4,950	4,950	4,960	4,960	4,970	+20	+0.4
Wells drilled per active rig	29.1	30.3	30.2	30.2	30.0	29.9	29.8	−0.5	−1.7
Footage drilled per active rig	143,543	150,025	149,440	149,400	148,935	148,280	148,270	−1,755	−1.2
REVENUE AND COST									
Average well cost ($)	370,490	377,900	391,120	408,720	425,070	439,950	459,740	+81,840	+21.7
Total wellhead revenues ($ million)	85,489	73,219	74,221	73,804	80,576	85,182	91,139	+17,920	+24.5
Total drilling expenditures ($ million)	10,887	19,766	11,805	12,830	13,785	15,125	16,460	+5,694	+52.9
% of wellhead revenues invested in drilling	12.7	14.7	15.9	17.4	17.1	17.8	18.1	+3.4	+23.1
PRODUCTION									
Capital expenditures ($ million)	3,957	3,485	4,435	4,820	5,170	5,380	5,860	+2,375	+68.1
Producing wells (oil & gas) (Dec. 31st)	858,164	847,880	844,770	841,500	843,930	847,720	852,500	+4,620	+0.5
Abandoned wells	32,307	30,000	24,000	25,000	20,000	20,000	20,000	−10,000	−33.3
PRICES									
Crude oil (Average wellhead-$/barrel)	20.03	16.80	16.10	15.20	16.60	17.50	18.90	+2.10	+12.5
Natural gas (Average wellhead-$/barrel)	1.72	1.55	1.75	1.90	2.10	2.25	2.40	+0.85	+54.8

OUTLOOK 2000 — EXPLORATION, DRILLING, PRODUCTION

				Change			% Change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
DRILLING ACTIVITY-U.S.									
Active drilling rigs	1,010	1,150	1,350	+140	+200	+340	+13.9	+17.4	+33.7
Well completions	29,385	34,380	40,355	+4,995	+5,975	+10,970	+17.0	+17.4	+37.3
Footage drilled (thousands)	144,978	170,525	202,180	+25,547	+31,655	+57,202	+17.6	+17.4	+39.5
Average well depth	4,934	4,960	5,010	+26	+50	+76	+0.5	+18.6	+1.5
Wells drilled per active rig	29.1	29.9	29.9	+0.8	—	+0.8	+2.7	—	+2.7
Footage drilled per active rig	143,543	148,280	149,760	+4,737	+1,480	+6,217	+3.3	+1.0	+4.3
REVENUE AND COST									
Average well cost ($)	370,490	439,950	535,250	+99,460	+95,300	+164,760	+26.8	+21.7	+44.5
Total wellhead revenues ($ million)	85,489	85,182	113,006	−307	+27,824	+27,517	−0.4	+32.7	+32.2
Total drilling expenditures ($ million)	10,887	15,125	21,600	+4,238	+6,475	+10,713	+38.9	+42.8	+98.4
% of wellhead revenues invested in drilling	12.7	17.8	19.1	+5.1	+1.3	+6.4	+40.2	+7.3	+50.4
PRODUCTION									
Capital expenditures ($ million)	3,957	5,380	7,840	+1,423	+2,460	+3,883	+36.0	+45.7	+98.1
Producing wells (oil & gas) (Dec. 31st)	858,164	847,720	852,570	−10,444	+4,850	−5,594	−1.2	+0.6	−0.7
Abandoned wells	32,510	20,000	25,000	−12,307	+5,000	−7,307	−38.1	+25.0	−22.6
PRICES									
Crude oil (Average wellhead-$/barrel)	20.03	17.50	23.75	−2.53	+6.25	+3.72	−12.6	+35.7	+18.6
Natural gas (Average wellhead-$/barrel)	1.72	2.25	3.05	+0.53	+0.80	+1.33	+30.8	+35.6	+77.3

REFINING AND PETROCHEMICALS

It now appears that conditions have stabilized for the U.S. and worldwide refining industries. Crude oil prices have stabilized and demand for oil products appears to be moving up again.

The 1990–1991 conflict in the Middle East led to a rapid escalation in the price of crude oil. The higher price level had a temporary impact on the rate of economic growth, the consumption of energy, and the demand

for petroleum products.

The price of crude oil has a substantial impact on the refining and petrochemical sectors of the oil industry. Higher prices increase the feedstock costs for these facilities and results in higher product costs. Higher product costs can lead to an adjustment in product demand. This in turn has an impact on the refinery and petrochemical plant capacity utilization rate and therefore on product unit costs. In addition, a higher cost of energy can slow economic growth, and slower economic growth leads to lower product demand.

In contrast to this, lower prices tend to stimulate product demand. Lower crude oil prices leads to lower petroleum product prices. Lower prices encourages greater consumption and demand moves up. At higher demand levels refinery utilization rates move up and lower unit product costs. At higher levels of demand refinery margins tend to improve.

However, at higher levels of product and crude oil prices, many of the integrated companies will have much higher revenues. The additional revenues mean that there are additional funds for investment in facility upgrading and expansion. The industry is faced with a need for substantial investment in the future. Investment will be required for facility upgrading and to meet new environmental regulations.

The refining and petrochemical industries both in the United States and worldwide have gone through a prolonged period of adjustment during the last several years. The abrupt movements in crude oil and product prices that plagued exploration and drilling activity also had a substantial impact on the downstream sector of the worldwide oil and gas industry.

The movements in the refining and petrochemical industries did not appear as volatile as in the exploration and production sector. But these downstream sectors have also gone through significant changes. It does not appear as volatile because making significant changes in the level of activity in the refining and petrochemical industries requires a much longer time. Any reductions or additions to capacity are quite costly. Therefore careful analysis is required before making a major adjustment in operations. Adding basic refining distillation capacity requires considerable lead time for planning and construction. To add facilities for additional processing to handle heavier and more sour crudes, requires considerable lead time for planning and construction. To add new petrochemical capacity to meet new demand generated by economic growth requires time for planning and construction. All of these projects are major investments and therefore require careful detailed economic analysis.

The decision to make any of these changes requires a certain degree of certainty concerning future market prospects. Planning for potential future activity is much more difficult in today's rapidly changing markets than it was in the past. When demand was steadily on the rise through the 1950s, 1960s, and 1970s planning consisted of carefully timing new added capacity to meet expected needs.

During that period, there was a great deal of certainty about the future trend in demand and the potential capacity required. The level of risk was related to the timing of the investment.

This all changed in the late 1970s when demand peaked and turned down. Although the changes that followed in the refining business did not appear as volatile as in the exploration and production sector, they were probably just as significant if not more significant. The refining industry had not been through a similar cycle before—a cycle where overall capacity had to be reduced due to a new perception of demand. What was significantly different was the fact that fo 'he first time, long range expectations were for lower demand.

And now to confuse the issue, expecta-

U.S. REFINERY CAPACITY AND UTILIZATION

	Number of plants*			Total capacity†	Crude runs	Utilization rate	Excess capacity
	Operating	Shut-down	Total	(1,000 b/d)		(%)	(1,000 b/d)
1973	253	28	281	13,671.4	12,431	90.9	1,240.4
1974	257	27	284	14,361.5	12,133	84.5	2,228.5
1975	262	28	290	14,960.7	12,442	83.2	2,518.7
1976	265	22	287	15,236.6	13,416	88.1	1,820.6
1977	273	18	291	16,398.4	14,605	89.1	1,793.4
1978	290	12	302	17,047.7	14,739	86.5	2,308.7
1979	301	10	311	17,440.9	14,646	84.0	2,794.9
1980	311	8	319	17,988.1	13,482	74.9	4,506.1
1981	315	9	324	18,620.5	12,471	67.0	6,149.5
1982	254	47	301	17,889.7	11,774	65.8	6,115.7
1983	233	25	258	16,859.3	11,685	69.3	5,174.3
1984	214	33	247	16,137.1	12,044	74.6	4,093.1
1985	199	24	223	15,658.8	12,002	76.6	3,656.8
1986	192	24	216	15,458.9	12,716	82.3	2,742.9
1987	195	24	219	15,565.5	12,854	82.6	2,711.5
1988	195	18	213	15,915.4	13,246	83.2	2,669.4
1989	193	11	204	15,654.9	13,401	85.6	2,253.9
1990	194	11	205	15,572.0	13,409	86.1	2,163.0

*As of January 1. †As of January 1. Includes operating and operable shutdown.

Source: Energy Information Administration

REFINERY CASH OPERATING MARGINS

Year	Gulf Coast average (dollars per barrel) Margins
1975	−0.47
1976	0.26
1977	0.60
1978	0.53
1979	1.47
1980	1.55
1981	0.33
1982	0.27
1983	−0.46
1984	−1.10
1985	−0.02
1986	−0.01
1987	−0.41
1988	1.44
1989	1.01
1990	1.84

Source: Wright Killen & Co.

tions have changed again. Product demand again appears to be on the rise. Expectations now are for relatively low crude oil and product prices for an extended period. This is expected to translate into a continuous increase in demand. Therefore there will be increased pressure put on existing refining capacity.

All of these factors have introduced a great deal of uncertainty and risk into planning for the refining and petrochemical industries.

REVIEW

REFINING CAPACITY. Virtually from its inception, the refining industry in the United States has been an industry of slow, steady growth. The growth had been steady with few interruptions. The exceptions were only some minor slowdowns due to economic recessions. This changed dramatically at the end of the 1970s. Looking at just the last portion of that growth period illustrates vividly what was happening in the industry at the time of the transition.

Demand for petroleum products in the United States increased 8.9%, from 17.308 million bbl/d in 1973 to 18.847 million bbl/d in 1978. U.S. refining capacity moved up from 13.7 million bbl/d in 1973 to 18.6 million bbl/d in 1981, an increase of 4.9 million bbl/d or 36.2%. During that period, capacity was expanding to meet increasing actual demand and to meet the, what seemed to be certain, expected future demand. The number of plants operating increased from 253 in 1973 to 315 in 1981. Total plants moved up from 281 to 324. The number of available plants that were shut down was reduced from 28 in 1973 to just 9 in 1981.

The expansion phase in the refining sector actually continued beyond the peak period for demand. Refining capacity continued to increase through 1981, although demand had peaked in 1978. The refining industry in 1980 and 1981 was still operating under the guidance of old long-term outlooks that foresaw increasing demand. The initial downturn in demand was thought to be only temporary. And many new facilities to meet the expected future increase in demand were already under construction. Therefore excess capacity continued to be added well beyond

REFINERY RUNS BY DISTRICTS

	Crude runs 1,000 b/d									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
East Coast	1,202	1,103	960	1,019	1,061	1,122	1,153	1,198	1,189	1,189
Appalachian Dist. 1	158	132	93	77	87	92	101	98	98	95
Total Dist. 1	1,334	1,196	1,037	1,106	1,153	1,223	1,251	1,298	1,287	1,284
Appalachian Dist. 2	54	51	53	58	60	54	—	—	—	—
Ill., Ind., Ky.*	1,803	1,714	1,798	1,784	1,777	1,847	1,930	1,944	1,927	2,007
Minn., Wisc., Dak.	229	251	253	282	285	294	287	307	312	322
Okla., Kan., Mo.	883	763	642	636	617	627	627	665	665	683
Total Dist. 2	2,969	2,779	2,746	2,760	2,739	2,822	2,844	2,916	2,904	3,012
Texas:										
Inland	469	456	474	499	472	472	470	480	508	515
Gulf Coast	2,829	2,726	2,801	2,780	2,750	2,990	2,909	3,021	3,026	2,939
Louisiana Gulf	2,030	1,941	1,862	2,012	1,972	2,162	2,230	2,261	2,380	2,353
N. La., Ark.	163	162	170	177	168	170	164	176	169	182
New Mexico	81	77	75	68	60	63	66	69	70	70
Total Dist. 3	5,572	5,362	5,382	5,536	5,422	5,857	5,839	6,007	6,153	6,060
Total Dist. 4	425	416	420	436	432	431	437	452	458	460
Total Dist. 5	2,171	2,021	2,100	2,206	2,256	2,383	2,483	2,573	2,598	2,506
Total U.S.	12,471	11,774	11,685	12,044	12,002	12,716	12,854	13,246	13,401	13,409

*Beginning in 1987 includes Appalachian Dist. 2.

Source: Energy Information Administration

the year of peak demand.

Before the downturn was felt in the upstream segment of the business, it was being detected in the refining sector. Demand for petroleum products began to slip. But it was not interpreted immediately as an extended downturn in demand.

However in retrospect we know it was a major turning point. Demand for petroleum products in the United States fell for five consecutive years in response to the massive price increases of the mid and late 1970s. Demand fell 3.616 million bbl/d, 19.2%, to 15.231 million bbl/d in 1983. Even though demand was falling, refining capacity continued to increase through 1981. Crude runs peaked in 1979 along with demand for petroleum products and started to fall. Therefore, the refinery utilization rate began to fall.

With demand falling and refining capacity on the rise, a growing and large excess refining capacity developed in the United States and worldwide. The utilization rate in the United States, which was as high as 90.9% in 1973 and averaged 86.6% from 1973 to 1979, dropped to 75% in 1980. As demand continued to fall, the rate dropped to extremely low and unprofitable levels. The rate of utilization fell below 70%: 67% in 1981, 65.8% in 1982, and 69.3% in 1983. Prior to the downturn, between 1973 and 1979, excess capacity ranged from 1.2 million bbl/d to 2.8 million bbl/d. This was mainly contingency capacity to allow for maintenance downtime and surges in product demand. After 1979, excess capacity jumped up to 4.5 million bbl/d in 1980 and to 6.1 million bbl/d in 1981 and 1982.

With excess refining capacity, refining margins and profits fell sharply. While earnings from exploration, drilling, and production activities were still substantial, the refining sector was experiencing a period of low earnings and even losses for some operations.

The drop in demand also resulted in a change in the long range perception and the long range forecasts of petroleum product demand. Past expectations of product demand increasing in step with the long range growth in economic

activity, and moving up 3–4%/year, were put to rest. Refiners realized that the lower demand levels they were experiencing were not a temporary economic phenomenon. They realized that they could not simply wait for demand to return to the previous growth trend. The refining industry realized that a capacity adjustment to lower demand levels was going to be required. Capacity would have to be reduced in order to increase the utilization rate, cut unit costs, and improve margins and profits.

From the peak in 1981, annual average total distillation capacity moved down 17%, falling to 15.5 million bbl/d in 1986. This was a cut in capacity of 3.162 million bbl/d. The number of plants operating fell from 315 in 1981 to 192 in 1986, a drop of 123. The total number of plants was down from 324 to 223, off 101. The number of plants temporarily shut down moved up to 24. And many plants were closed permanently.

Refining capacity was reduced in order to close the gap between capacity and demand. The operating objective was to boost the utilization rate, reduce unit costs, improve margins, and increase profitability.

The refining industry had historically operated in an atmosphere of ever expanding refining capacity in response to demand for products. Adjusting their planning process to accommodate a shrinking industry was difficult. But it was realized that a leaner and more efficient industry was essential if refinery margins and profitability were to improve.

Demand for petroleum products turned around again in 1984, after prices had fallen sufficiently to slow the conservation effort. It has grown slowly and steadily since that time. Demand in 1989 was 17.325 million bbl/d, up 2.094 million bbl/d, 13.7%, since 1983. As a result of this upward shift in demand, the slide in refining capacity was stopped. In fact, refining capacity increased slightly in 1987 and 1988 due to the higher product demand. Average annual refining capacity increased 456,500 bbl/d. Restructuring and consolidation in the industry resulted in a reduction in capacity in 1989, down 260,500 bbl/d. Refining capacity slipped a marginal 32,000 bbl/d in 1990 to an average 15.623 million bbl/d.

Most projections now call for improved demand in the future. Refining is a competitive business. Capacity is being adjusted as refiners attempt to define their most profitable market, increase market share, or make other adjustments to increase profitability.

The utilization rate, based on crude runs, has moved back up to a more acceptable and profitable level. The utilization rate during the last four years has been 82.6% in 1987, 83.2% in 1988, 86.5% in 1989, and 87.1% in 1990. Due to this improvement in the utilization rate, increased demand, and improved efficiency, the financial conditions in the refining industry have improved markedly.

In 1985–86 the refining sector received a financial boost when a number of OPEC countries, led by Saudi Arabia, adopted net-back pricing. At that time the market was flooded with readily available crude oil and crude costs plummeted.

The combination of lower crude costs and net-back pricing boosted refining margins substantially for a short period. Lower crude costs meant lower refinery feedstock costs. Crude costs fell faster than product costs. And for many refiners net-back contracts virtually locked in a profit margin for every barrel of crude purchased and processed.

But with the OPEC adoption of new production quotas in late 1986 and 1987 and a tightening of the market, crude prices moved back up. Net-back pricing was scrapped by the crude producers, and refining margins disappeared.

However, in 1988 there was another surge in refining margins and refining prof-

itability. Crude costs slid that year, lowering feedstock costs. In addition, demand continued to move up, increasing the refinery utilization rates, lowering unit production costs, and improving operating margins. At the same time increased demand boosted revenues. Product prices remained relatively stable, not falling along with crude costs. The result was a sharp increase in refining profits. For example, U.S. Gulf Coast refiners' cash operating margins average a -$0.58/bbl in 1987. In 1988 this changed to an average of $1.42/bbl margin. The average margin slipped but remained positive at $0.99/bbl in 1989. The average U.S. Gulf Coast refiner's cash operating margins moved up to $1.69/bbl in 1990.

In past years, even with an excess capacity problem in refining, capital expenditures for refining facilities remained relatively high during the 1981–1985 period. A substantial portion of the investment was for upgrading capacity to produce a higher yield of lighter products and to handle heavier sour crude oils. The investments have been made because expectations are that demand for lighter products will increase in the future much faster than for the heavier fuel oil. Therefore as overall distillation capacity was falling, upgrading capacity was increasing.

Illustrative of the shift to a greater demand for lighter products is the shift in resid and gasoline demand. In 1977 resid demand represented 16.7% of the barrel and gasoline 38.9%. By 1985 this had shifted to resid only 7.6% and gasoline 43.4%. There was a slight reversal in this trend in 1986 as resid moved up to 8.7% and gasoline dropped to 43.2%. But when prices moved back up in 1987, resid fell to 7.6%. With lower prices resid demand moved up in 1988, and the resid portion rose to 8%. In 1989 resid demand represented 7.9% of total demand and motor gasoline 42.3%. In 1990 the proportion was 7.2% resid and 42.6% motor gasoline. The estimate for 1991 was 6.9% resid and 42.9% motor gasoline. There are some signs that there could be a resurgence in resid demand. The continued increase in demand for electrical power will require additional fuel for power generation. If prices remain at a level low enough for resid to compete in the industrial and utility markets, demand could rebound.

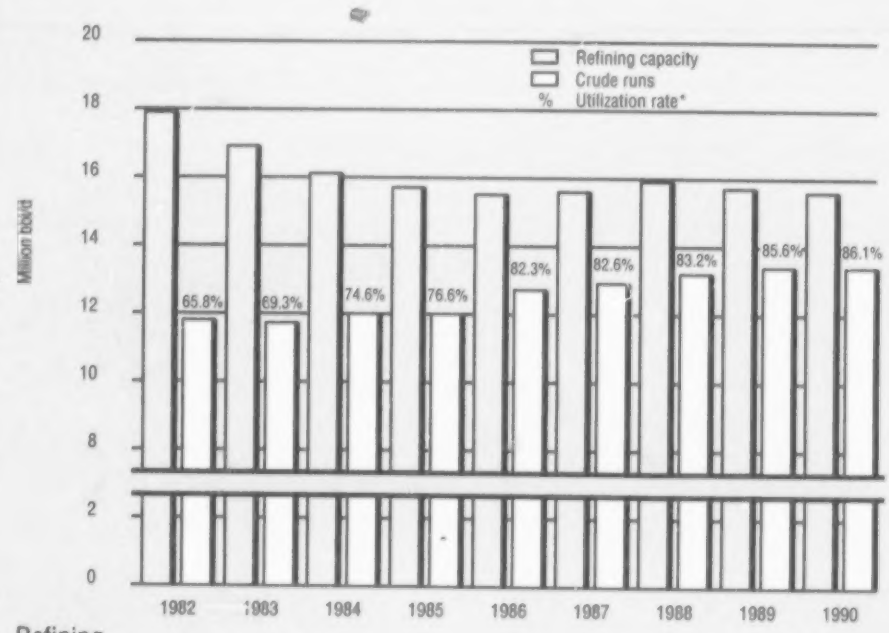
Nevertheless, during the past few years the investment has been concentrated more in upgrading and modernization. Capital spending for refining facilities moved up rapidly between 1978 and 1982, increasing from $1,551 million to $5,775 million. During the next four years, while in the downturn, refining outlays fell steadily to an estimated $2,073 million in 1986. The trend reversed in 1987, and investment increased to $2,180 million. It moved up again in 1988 to $2,874 million. Modernization continued and there was some additional capacity added. Capital expenditures in 1989 moved up to $4,402 million. Spending on refining jumped up sharply in 1990 to $5,790 million. It is obvious that the improved profitability and increased demand has encouraged additional investment.

REFINING MARGINS. One of the key financial indicators of the efficiency of refining operations is refining margins. Margins measure the difference between the value of the products from the refined barrel and the combined cost of feedstocks and refining operations.

During the latter part of the expansion period, the total value of the refined barrel went from $14.73 in 1977, prior to the second large price hike, to $39.07 in 1981. The refiners' acquisition cost of crude moved up from $11.96 in 1977 to $35.24 in 1981. Between 1977 and 1981, the net value to the refiner after subtracting refining costs was generally positive, averaging about $0.89/bbl.

However, in subsequent years, rapidly rising crude oil costs coupled with rising refin-

U.S. REFINING CAPACITY AND CRUDE RUNS



	1982	1983	1984	1985	1986	1987	1988	1989	1990
Refining capacity	17.9	16.9	16.1	15.7	15.5	15.6	15.9	15.7	15.6
Crude runs	11.8	11.7	12.0	12.0	12.7	12.9	13.2	13.4	13.4

* Crude runs as percent of capacity
Source: Energy Information Administration

ing costs, as the utilization rate fell, turned net margins negative. Falling product sales and high unit costs due to the low capacity utilization rate kept margins generally low or negative.

Increased demand and a higher refinery utilization rate helped refinery margins improve in 1985. And in 1986, low crude costs and an even higher utilization rate boosted margins again. Net-back contracts with some major OPEC producers also helped some refiners.

When crude costs moved back up in 1987, operating margins again turned negative. A very competitive product market kept product prices from moving up. Therefore margins were squeezed when feedstock costs increased with the higher crude prices.

The situation was reversed in 1988. Falling crude prices reduced feedstock costs. At the same time, strong product demand enabled refiners to hold the line on product prices. This resulted in substantially improved margins. Margins started out the year negative but then

rapidly moved up as crude prices fell. By the end of the second quarter of 1988, margins had reached some of the highest levels in recent years. Refining margins remained positive but were down somewhat at the end of 1988. Margins in 1989 stayed positive for most of the year and finished the year quite strong. Refining margins hit close to record levels in some months of 1990. Crude oil costs fell sharply in the first half of the year, but product prices remained up due to relatively strong demand. This resulted in strong margins from April through August 1990. Although crude oil prices moved up rapidly due to the Iraq invasion of Kuwait, refiners were able to maintain positive margins from October through November. The year posted one of the highest average annual refining margins on record.

Refining margins have remained positive in 1991 as increased efficiency and low unit costs due to high utilization rates have helped maintain profitability.

PETROCHEMICALS. Companies in the petrochemical industry posted record profits in 1988 and 1989. The continuing increase in economic activity boosted demand for petrochemical products. Increased demand and relatively stable prices boosted revenues substantially. Also, with increased demand the utilization rate moved up and cut unit operating costs. This combined with low or falling feedstock costs increased margins and boosted profits.

The level of activity in the chemical/petrochemical industry closely follows the growth pattern of the overall economy. The U.S. economy had been going through an unprecedented period of continuous growth which boosted demand for petrochemicals to record levels. Rising demand helped eliminate the excess capacity problem that had depressed the industry for several years. However, success has led to additional capacity worldwide and a return in 1989 to a new period of excess petrochemical capacity.

Rapidly rising crude prices in the late 1970s and early 1980s had an impact on the petrochemical industry similar to the impact on refining. Increased crude prices meant increased feedstock costs for the petrochemical industry. This reduced margins and forced the industry to boost prices to recover the higher feedstock costs. The higher product prices tended to reduce demand.

Demand leveled off and an excess capacity problem developed. Worldwide capacity additions had exceeded demand for several years. Capacity had been built up in the anticipation of ever increasing demand. Besides capacity additions in the industrial countries, additional capacity has been added recently in the Middle East, aggravating this situation. Some of the OPEC countries have been investing in downstream facilities as part of their long range growth plans.

The estimated U.S. capacity utilization rate fell as low as 66% in 1982. In 1982 higher product prices resulting from rising feedstock costs and slower growth in economic activity reduced demand for petrochemicals. This further aggravated the excess capacity situation.

Demand picked up in 1983 and 1984, increasing at an annual rate of about 7–8%. It stagnated in 1985–1986, showing little net growth over that two-year span. But general worldwide economic growth in 1987 and 1988 again boosted demand. Growth during those two years is estimated at over 8% per year.

Capacity additions were held in check during this period, and therefore the utilization rate moved up sharply. It was estimated that in 1988, plants worldwide were operating at over 90% of capacity. However, recent capacity additions and some slowdown in demand may have markedly changed the rate in 1989 and

into 1990.

U.S. ethylene capacity was cut from the high of around 18.2 million metric tons per year in 1981 to 16.985 million metric tons in June 1988. This put capacity more in line with demand estimated at 16 million metric tons per year.

During the period of excess capacity, the petrochemical industry found itself trapped with sluggish demand and depressed margins. Feedstock costs were high. The utilization rate was low which increased unit production costs. Demand was not increasing, and product prices were held low because of intense competition.

This situation had changed dramatically by 1987–1988. Demand had risen substantially and was continuing up. Prices were firm due to increased demand and less excess capacity. The operating rates were up which reduced costs. And feedstock costs were relatively low due to low crude prices. As a result, petrochemical margins were up substantially, and good profits were being posted.

U.S. Gulf Coast average cash margins for ethane propane (E/P) mix were 2.72 ct/lb of ethylene produced back in 1985. This had moved up to over 20 ct/lb in 1988. Light naphtha cash margins were only 0.20 ct/lb of ethylene in 1985. This was up to over 25 ct/lb in 1988. Margins started out very strong in 1989 but then weakened substantially toward the end of the year. Margins for E/P mix fell 39% from January 1989 at 22.15 ct/lb to December 1989 at only 13.59 ct/lb. The average for the year was 20.3 ct/lb. The average E/P mix cash margin for 1990 fell 40.2% to 12.14 ct/lb.

The same pattern has been true for light naphtha. The margin dropped from 32.92 ct/lb of ethylene in January 1989 to 15.45 ct/lb in December, a decline of 53%. The average for the year was 25.67 ct/lb. Light naphtha margins also fell sharply in 1990 averaging 14.71 ct/lb, down 42.7% from 1989. Weaker demand due to economic recession and some excess capacity have led to these lower margins.

There is a lot of optimism in the petrochemical industry. But the huge margins posted in past years have led to additional capacity being added. This may result in another period of excess capacity in the 1990s. U.S. ethylene capacity moved up 7.5% from 17.786 million metric tons/year in 1989 to 19.122 million metric tons/year in 1990. Total world capacity also increased, moving up 7.8% to 54.043 million metric tons/year in 1990. The increase in the United States was one of the largest, but the other areas of the world also posted increases: Latin America +25.1%, Western Europe +1.9%, Asia Pacific +6.8%, and all other areas +20.9%. The concern about excess capacity may now be fact rather than expectation. The ability to profitably use this additional capacity will depend upon the rate of growth in economic activity.

OUTLOOK

This year the oil market has remained quite stable. Following the conflict in the Middle East, oil prices slipped slightly and then stabilized. Even though crude oil from Iraq and Kuwait has not returned to the market, prices have not increased substantially. Prices have stabilized at a level that is slightly higher than past years. The higher price level is due to the rather tight supply situation in the world oil market.

Last year the embargo on crude oil from occupied-Kuwait and Iraq and the loss of a substantial volume of crude oil led to a sharp increase in prices. Part of that increase was a risk premium being paid for crude oil because of fear of a shortage and fear that if a war broke out additional capacity would be lost to the market.

However conditions have changed dramatically during the past year. Last year there was the possibility of a lengthy period of high crude oil costs because of the uncertainty in the Middle East. And higher crude oil prices result in higher feedstock costs for refining and petrochemical facilities and also results in higher product costs. This in turn can lead to a reduction in product demand. The level of product demand determines the refinery and petrochemical throughput and the refinery and petrochemical plant capacity utilization rate. And this determines the unit cost of products. In addition, a higher cost of energy can slow economic growth and further reduce product demand.

The outlook is quite different this year. The conflict in the Middle East has been settled in a manner that appears to offer stability in the industry for an extended period. It now appears that crude and product price increase will be modest during the forecast period. This in turn is expected to stimulate product demand. Refinery throughput is expected to move up, and the refinery utilization rate is expected to remain very high.

Higher product demand should lead to higher profitability and help provide the capital refiners will need for the future. Additional funds will be required for investment in facility upgrading, expansion, and to meet new environmental requirements. Meeting environmental requirements and still meeting expanded product demands are going to be the challenges for the refining industry during the forecast period.

Base Scenario — The stabilization of prices in 1991 will result in lower feedstock costs for refiners. And it is expected that lower crude oil prices in the next couple of years, due to increased crude capacity, will mean a lower crude oil refiner acquisition cost. The U.S. composite refiner acquisition cost of crude oil is estimated to fall to $19.45/bbl in 1991, down 12.5% from $22.23/bbl in 1989. The average pump price of motor gasoline is expected to move up slightly in 1991 to $1.25/gal, up 2.5% from $1.22/gal in 1990. The increase will be mainly due to a $.05/gal increase in the federal tax. Distillate home heating fuel oil is projected to fall marginally to $1.05/gal in 1991. Due to the recession in the United States, demand for petroleum products will fall 1.7% to 16.695 million bbl/d in 1991.

Because of the increase in crude oil capacity in 1992, the crude costs will drop, and the composite refiner acquisition cost of crude oil will fall 5.4% to $18.40/bbl. The average pump price of motor gasoline will drop 2.4% to $1.22/gal, and distillate home heating fuel oil will fall 4.8% to $1.00/gal. With lower product prices and revived economic growth, total demand for petroleum products will move up 1.6% to 16.97 million bbl/d.

During the remainder of the forecast period, the crude price and the refiner acquisition cost will move up gradually. The refiner acquisition cost will move up to $21.60/bbl in 1996. The average pump price for motor gasoline will move up to $1.35/gal, and the price of home heating fuel oil will move up to $1.15/gal. Total product demand will climb to 18.175 million bbl/d. This will be up 1.48 million bbl/d from demand in 1991.

Total U.S. refining capacity will reverse directions and is projected to increase slightly over the 1991–1996 forecast period. The capacity additions will be made throughout the forecast period. But the capacity additions will be small. It is unlikely that any large new refineries will be built during the forecast period because of the difficulty with environmental regulations and permitting. Total U.S refining distillation capacity is expected to increase only 1.3% to 15.9 million bbl/d in 1996. The increase in capacity will be less than

the increase in demand, so the refinery utilization rate will move up during the forecast period.

Refiners prefer a utilization rate of 85–90%. This rate is more efficient and profitable. Refinery crude runs and total input to distillation units will increase with demand. Crude runs will move up 6% to 13.965 million bbl/d in 1996, and inputs to distillation units will increase to 14.165 million bbl/d in 1996. Most of the increase in demand will be met by increased domestic product production. As a result, the refinery utilization rate will move up. The utilization rate will increase steadily during the next five years and is projected to increase to 89.1% in 1996.

Increased demand could be supplied by product imports also, but refiners prefer to utilize existing refining capacity if possible. However, with limited expansion of refining capacity, some of the increase in future demand will have to be met by increased product imports. Product imports are not expected to move up as rapidly as demand during the forecast period, but the increase will be substantial. In any year the increase will depend upon the relative cost of imported products compared to the domestic cost of production. Product imports are projected to increase 600,000 bbl/d to 2.4 million bbl/d in 1996.

Crude imports are projected to move up much faster than either demand or refinery crude runs. Crude imports will move up 1.55 million bbl/d to 7.46 million bbl/d in 1996, an increase of 26.2% over the 1991 level. The rapid increase in crude imports means refiners will be processing a great deal more foreign crude in the future years.

Capital spending is expected to remain relatively high in the future to meet changing product demand patterns and to meet changing crude qualities. It will be essential to have the ability to handle the heavier crudes and to be able to upgrade the output and produce a greater yield of lighter products. This will be essential for long-term profitability in the refining industry. Even though resid demand is expected to increase over the long run, lighter products will be the most profitable for refiners.

Capital spending in the refining industry is projected to move up through the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading capacity. New environmental rules will also result in increased investment for new facilities. As concern for the environment grows, so do regulations and required investment to meet these regulations. Environmental requirements are expected to be substantial.

Capital spending in the refining industry is projected to increase 29.4% during the forecast period, moving up to $7.495 billion in 1996.

Refiners at present are operating quite profitably. Increased profitability in the future will depend upon increased demand and increased refining operating efficiency.

During the forecast period, crude oil costs are expected to move up only slightly faster than product prices. This will somewhat close the gap between feedstock costs and product values. But profitability could remain fairly high. The increased utilization rate will reduce unit operating costs. And increased demand will boost total revenues.

Refiners will not have the luxury of net-back deals to ensure improved margins during the forecast period. However, several refiners have worked out or shown interest in joint agreements with producing countries. This type of renewed vertical integration could help boost profits also. It would remove some of the uncertainty and allow for more efficient planning.

The future for the petrochemical industry also appears favorable. Demand is

expected to grow at an annual rate of 4–5%. The one problem that may arise during the forecast period is the development of excess capacity in the early 1990s. The large additions in 1990 indicate that this may already be taking place. However, some of the increase may be offset by the idling of some older capacity. If demand does not keep pace with these additions, then excess capacity will reduce operating rates. This would reduce margins and profitability.

Another related problem that could arise is increased foreign competition. Demand has increased in Europe and elsewhere in the world. This may result in substantial capacity being added overseas. The additions in 1990 also may be the start of increasing non-U.S. capacity. In addition, there are the new petrochemical export facilities in the Middle East that are producing low cost product intended for export. These facilities have very low feedstock costs and in some cases have government subsidies.

The result could be low cost foreign petrochemicals competing in the U.S. market and depressing prices. This has resulted in some petrochemical producers planning to move away from the feedstock intensive commodities business and shift towards the higher value added specialty products markets.

Capital spending by the U.S. oil companies on petrochemical facilities is expected to increase 31% during the forecast period to $4.29 billion in 1996.

This indicates that the industry is optimistic about increased demand. The major reason is continued economic growth both in the United States and worldwide. Despite the potential problems associated with excess capacity and the environment, the expectations are for future growth and increased profit potential over the forecast period.

REFINING AND PETROCHEMICALS

KEYS TO THE FUTURE

1. Demand for petroleum proucts in the United States will increase throughout the forecast period. Demand growth will be resumed in 1992 as the United States comes out of the recession and economic growth resumes. Demand will be up 8.9% by 1996, an increase of 1.48 million bbl/d to 18.175 million bbl/d.

2. U.S. refining capacity will move up along with demand and crude runs. Capacity will be expanded to 15.9 million bbl/d by 1996, up 210,000 bbl/d, an increase of 1.3%. Capacity additions will not keep pace with the increase in demand.

3. Increased crude runs to meet demand will boost the refinery utilization rate and maintain it at a profitable level. Crude runs will increase more than capacity and this will boost the utilization rate and help increase profitability. The refining capacity utilization rate will move up from 85.2% in 1991 to 89.1% in 1996.

4. Crude costs will move up slightly faster than product prices. However, increased demand and lower refinery operating costs should help maintain margins.

5. Product imports will move up, filling the gap between increased demand and increased domestic refinery output. Product imports will increase 33.3% to 2.4 million bbl/d in 1996. Product imports could be higher if import prices are competitive.

6. Petrochemical demand will continue to move up during the forecast period. Continued growth in economic activity will boost product demand. Worldwide plans to add to petrochemical capacity could result in periodic excess capacity problems during the forecast period.

7. The need for additional capacity and capacity upgrading and modernization will boost capital spending for both refining and petrochemicals. Spending on refining will move up 29.4% to $7.46 billion in 1996. Spending on petrochemicals will be up 31% by 1996 at $4.29 billion.

8. Environmental concerns and regulations will result in additional operating problems and additional investment requirements for the refining and petrochemical industries.

THE OUTLOOK — REFINING AND PETROCHEMICALS

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
U.S. DOMESTIC DEMAND									
(thousand barrels/day)	16,988	16,695	16,970	17,285	17,580	17,875	18,175	+1,480	+8.9
U.S. REFINING									
(thousand barrels/day)									
Refining capacity	15,623	15,690	15,710	15,750	15,800	15,050	15,900	+210	+1.3
Crude runs	13,409	13,180	13,260	13,450	13,620	13,790	13,965	+785	+6.0
Input to distillation units	13,610	13,370	13,450	13,645	13,815	13,990	14,165	+795	+5.9
Refinery utilization rate (%)	87.1	85.2	85.6	86.6	87.4	88.3	89.1	+3.9	+4.6
U.S. IMPORTS									
(thousand barrels/day)									
Crude imports (ex SPR)	5,867	5,910	6,160	6,540	6,835	7,160	7,460	+1,550	+26.2
Crude Imports—% of crude runs	43.8	44.8	46.5	48.6	50.2	51.9	53.4	+8.6	+19.2
Product imports	2,124	1,800	2,000	2,100	2,200	2,300	2,400	+600	+33.3
Product imports—% of demand	12.5	10.8	11.8	121	12.5	12.9	13.2	+2.4	+22.2
CAPITAL SPENDING									
($ million)									
Refining	4,402	5,790	6,170	6,510	6,850	7,205	7,495	+1,705	+29.4
Petrochemical	3,125	3,275	3,390	3,600	3,835	4,125	4,290	+1,015	+31.0
Total	**7,527**	**9,065**	**9,560**	**10,110**	**10,685**	**11,330**	**11,785**	**+2,720**	**+30.0**
PRICES									
Crude oil									
U.S. refinery acquisition cost									
($/barrel)									
Domestic crude	22.60	19.80	18.80	17.80	19.40	20.40	22.00	+2.20	+11.1
Imported crude	21.78	19.10	18.00	17.00	18.60	19.60	21.20	+2.10	+11.0
Composite price of crude	22.23	19.45	18.40	17.40	19.00	20.00	21.60	+2.15	+11.1
Motor gasoline pump price									
($/gallon)	1.22	1.25	1.22	1.20	1.25	1.30	1.35	+0.10	+8.0
Distillate fuel oil—home heating									
($/gallon)	1.06	1.05	1.00	0.95	1.05	1.10	1.15	+0.10	+9.5

OUTLOOK 2000 — REFINING AND PETROCHEMICALS

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
U.S. DOMESTIC DEMAND									
(thousand barrels/day)	16,988	17,875	18,820	+887	+945	+1,832	+ 5.2	+ 5.3	+10.8
U.S. REFINING									
(thousand barrels/day)									
Refining capacity	15,623	15,850	16,000	+227	+150	+377	+1.5	+0.9	+2.4
Crude runs	13,409	13,796	14,300	+381	+510	+891	+2.8	+3.7	+6.6
Input to distillation units	13,610	13,990	14,500	+380	+510	+890	+2.8	+3.6	+6.5
Refinery utilization rate (%)	87.1	88.3	90.6	+1.2	+2.3	+3.5	+1.4	+2.6	+4.0
U.S. IMPORTS									
(thousand barrels/day)									
Crude imports (ex SPR)	5,867	7,160	8,140	+1,293	+980	+2,273	+22.0	+13.7	+38.7
Crude imports—% of crude runs	43.8	51.9	56.9	+8.1	+5.0	+13.1	+18.5	+9.6	+29.9
Product imports	2,124	2,300	2,890	+176	+590	+766	+8.3	+25.7	+36.1
Product imports—% of demand	12.5	12.9	15.4	+0.4	+2.5	+2.9	+3.2	+19.4	+23.2
CAPITAL SPENDING									
($ million)									
Refining	4,402	7,205	9,130	+2,803	+1,925	+4,728	+63.7	+26.7	+107.4
Petrochemical	3,125	4,125	5,890	+1,000	+1,765	+2,765	+32.0	+42.8	+88.5
Total	7,527	11,330	15,020	+3,803	+3,690	+7,493	+50.5	+32.6	+99.5
PRICES									
Crude oil									
U.S. refinery acquisition cost									
($/barrel)									
Domestic crude	22.60	20.40	27.70	−2.20	+7.30	+5.10	−9.7	+35.8	+22.6
Imported crude	21.78	19.60	26.50	−2.18	+6.90	+4.72	−10.0	+35.2	+21.7
Composite price of crude	22.23	20.00	27.00	−2.23	+7.00	+4.77	−10.0	+35.0	+21.5
Motor gasoline pump price ($/gallon)	1.22	1.30	1.75	+0.08	+0.45	+0.53	+6.6	+34.6	+43.4
Distillate fuel oil—home heating ($/gallon)	1.06	1.10	1.45	+0.04	+0.35	+0.39	+3.8	+31.8	+36.8

TRANSPORTATION

It now appears that the quick and successful resolution to the conflict in the Middle East has stabilized the energy industry and will give a boost to oil and gas trade in the future. The conflict seemed to encourage many producing countries to develop plans to expand their production capacity. This additional capacity will tend to prevent any surge in oil and energy prices in the near future. And moderate prices will

stimulate energy consumption and demand. Increased demand will in turn stimulate the demand for transportation equipment and facilities.

Any upward movement in demand will be directly translated into increased imports. The lower oil prices will not only stimulate demand but it will tend to depress the development of high cost non-OPEC production throughout the world. This will mean that oil consuming areas will become more dependent upon production from the countries with large reserves and low cost production. Most of the low cost producing countries are in OPEC and in the Persian/Arabian Gulf region. Long haul imports from these areas will move up faster than demand.

The increase in demand and imports will mean a sharp increase in the demand for all forms of transport. Obviously, increased demand for oil from the OPEC and Middle Eastern countries will increase the need for oil tanker vessels. But in addition to this, increased product demand will increase the need for new pipelines and additional land transport.

Another aspect of the increase in transport needs is the increase in worldwide trade in natural gas. Concerns with the changes in the environment and the pollution caused by the burning of some fuels has led to a worldwide search for cleaner burning fuels. In the initial stages of the search for cleaner energy, many countries are turning toward natural gas as a solution to the more pressing immediate problems. This is leading to a surge in worldwide trade in natural gas. However, one of the greatest problems facing this aspect of the industry is equipment and facilities to facilitate trade in natural gas. It is expected that investment in vessels for the transport of liquified natural gas and pipelines for overland transport of natural gas could be substantial during the forecast period.

The changes in the transportation portion of the oil and gas industry are related to the location and volume of production and the location and level of consumption. The location and volume of crude oil and natural gas production are constantly changing throughout the world and within the United States. The level and location of consumption is also changing with changes in economic activity. These changes also vary throughout the world and within the United States. During the past several years, the changes have been quite dramatic.

The level of activity in the transport sector is dependent upon the volume and location of the crude oil, petroleum products, or natural gas to be moved. With the location of production, processing, and consumption continually changing, distribution patterns are constantly changing. Shifting distribution patterns change transport needs and operations even if volumes are not increasing. This is true for all aspects of transport: pipelines, water going vessels, tanker trucks, or trains.

REVIEW

Substantial changes in the level and location of production, consumption, and import/export levels of both crude oil and natural gas have occurred during the past 20 years.

Many of the changes were very dramatic. Demand for petroleum products in the United States dropped 3.616 million bbl/d between 1978 and 1982. Following this period, between 1982 and 1989 the trend reversed and demand moved up, increasing 2.094 million bbl/d. During the past 2 years, demand has slipped again, falling 630,000 bbl/d to 16.695 million bbl/d. These large swings in demand for products obviously had an impact on product distribution patterns and transport requirements in the United States.

On the production side of the industry, the swings were also dramatic. With the rapid rise in prices, U.S. output of crude oil moved up from 8.132 million bbl/d in 1976 to a recent peak of 8.971 million bbl/d in 1985. Then after prices plummeted in 1986, crude production started to slide and by 1990 had slipped to an average of 7.355 million bbl/d. During this period Alaskan production moved up steadily from 173.000 bbl/d in 1976 to 2.017 million bbl/d in 1988. However this trend may have reversed also. Alaskan production fell to 1.874 million bbl/d in 1989 and 1.773 million bbl/d in 1990. Although the downward trend in production is expected to continue indefinitely, in 1991 Alaskan and U.S. production could both be up slightly from 1990.

Import levels also went through some large changes during this period. Crude oil imports moved up from 3.244 million bbl/d in 1973 to 6.615 million bbl/d in 1977 and 6.519 million bbl/d in 1979. Then as U.S. demand slipped, crude imports fell sharply to 3.201 million bbl/d in 1985. These huge changes in import levels had a tremendous impact on the international crude oil tanker business.

And the dramatic shifting in import levels has not ceased. Imports have been moving up rapidly since 1985. Crude imports moved up to 5.894 million bbl/d in 1990.

These sharp swings in product demand, crude production, and imports have resulted in substantial alterations in distribution and transport operations and facilities.

Natural gas has also gone through some sharp shifts in consumption, production, and imports. U.S. consumption of natural gas ranged from 19.4 to 20.2 trillion cubic feet (tcf) between 1975 and 1981. Consumption started to fall in 1982 and dropped as low as 16.2 tcf in 1986. But with lower prices and increased economic activity this trend also reversed. Natural gas consumption is now on the rise and reached 18.803 tcf in 1990.

Marketed production of natural gas in the United States followed a somewhat similar pattern. Domestic U.S. marketed production fell from 20.2 tcf in 1980 to 16.8 tcf in 1986. Domestic production has moved up the last

U.S. INTERSTATE PIPELINE MILEAGE

Year	Miles Gas	Liquid	Total
1980	274,248	172,673	446,921
1981	274,634	172,815	447,449
1982	286,999	172,549	459,548
1983	285,204	167,819	453,023
1984	258,379	173,922	432,301
1985	279,395	171,401	440,796
1986	281,881	170,014	451,895
1987	280,085	167,865	447,950
1988	281,381	170,457	451,838
1989	273,401	168,637	442,038

Source: Oil & Gas Journal

PIPELINE CONSTRUCTION—1991 AND BEYOND*

Area	†4-10 in.	12-20 in.	22-30 in.	Larger than 30 in.	Total
	Miles				
GAS PIPELINES					
U.S.	106	569	1,881	3,515	6,071
Canada	—	22	491	3,487	4,000
Latin America	789	519	519	—	1,827
Asia-Pacific	112	860	441	227	1,640
Western Europe	201	287	258	2,350	3,096
Middle East	—	—	—	880	880
Africa	3	9	17	741	770
Total gas	**1,211**	**2,266**	**3,607**	**11,200**	**18,284**
CRUDE PIPELINES					
U.S.	—	139	122	130	391
Canada	—	—	130	150	280
Latin America	—	271	—	199	470
Asia-Pacific	338	361	—	—	699
Western Europe	22	137	161	—	320
Middle East	—	—	—	1,340	1,340
Africa	1,096	632	43	23	1,794
Total crude	**1,456**	**1,540**	**456**	**1,842**	**5,294**
PRODUCT PIPELINES					
U.S.	246	45	—	—	291
Canada	—	—	—	—	—
Latin America	688	1,098	—	—	1,786
Asia-Pacific	70	1,337	1,517	—	2,924
Western Europe	525	500	—	—	1,025
Middle East	—	—	—	—	—
Africa	—	34	—	—	34
Total product	**1,529**	**3,014**	**1,517**	**—**	**6,060**
WORLD TOTALS					
Gas	**1,211**	**2,266**	**3,607**	**11,200**	**18,284**
Crude	**1,456**	**1,540**	**456**	**1,842**	**5,294**
Product	**1,529**	**3,014**	**1,517**	**—**	**6,060**
Total	**4,196**	**6,820**	**5,580**	**13,042**	**29,638**

*Projects planned and under way in 1991 and scheduled for completion beyond 1991. †Includes some projects of less than 4 in. diameter.

Source: Oil & Gas Journal

PIPELINE CONSTRUCTION IN 1991*

Area	†4-10 in.	12-20 in.	22-30 in.	Larger than 30 in.	Total
	Miles				
GAS PIPELINES					
U.S.	1,011	1,135	930	1,782	4,858
Canada	764	102	89	564	1,519
Latin America	–	–	–	236	236
Asia-Pacific	122	329	629	485	1,565
Western Europe	236	174	290	436	1,136
Middle East	–	67	93	–	160
Africa	–	22	–	–	22
Total gas	**2,133**	**1,829**	**2,031**	**3,503**	**9,496**
CRUDE PIPELINES					
U.S.	209	159	13	60	441
Canada	–	16	–	–	16
Latin America	37	49	290	–	376
Asia-Pacific	293	210	–	–	503
Western Europe	9	39	47	–	95
Middle East	–	–	–	63	63
Africa	19	84	57	–	160
Total crude	**567**	**557**	**407**	**123**	**1,654**
PRODUCT PIPELINES					
U.S.	388	126	–	–	514
Canada	–	8	–	–	8
Latin America	194	82	37	–	313
Asia-Pacific	22	–	15	–	37
Western Europe	864	175	–	–	1,039
Middle East	–	–	–	–	–
Africa	490	309	–	–	799
Total product	**1,958**	**700**	**52**	**–**	**2,710**
WORLD TOTALS					
Gas	**2,133**	**1,829**	**2,031**	**3,503**	**9,496**
Crude	**567**	**557**	**407**	**123**	**1,654**
Product	**1,958**	**700**	**52**	**–**	**2,710**
Total	**4,658**	**3,086**	**2,490**	**3,626**	**13,860**

*Projects under way at the start of 1991 or set to begin and be completed in 1991. †Includes some projects of less than 4 in. diameter.

Source: Oil & Gas Journal

few years and reached 18.469 tcf in 1990.

Imports of natural gas have also changed substantially. Imports averaged around 950 billion cubic feet (bcf) from 1974–1985. Imports fell to 750 bcf in 1986. But along with the increase in U.S. consumption and increased investment in export facilities in Canada, imports moved up to 993 bcf in 1987, 1,294 bcf in 1988, 1,382 bcf in 1989, and 1.512 bcf in 1990.

Changes in the location of production and consumption have accompanied these sharp swings in volume. And all of these changes have required adjustments in transport. These frequent changes end up requiring additional new investment in the transport sector of the oil and gas industry. Investment has continued at a good pace even though activity levels have changed dramatically. The new investment encompassed additions and changes in the capacity of all forms of transport: pipelines, water carriers, motor carriers, and railroad cars.

Reviewing past transport statistics shows how the traffic has changed in volume and how it has shifted between types of carriers. These statistics have not been updated recently, and the increase in imports expected in future years will undoubtedly result in new records being set. However, these statistics do show the volatility that also exists in the transport sector of the industry.

The total ton miles of crude oil and petroleum products carried in U.S. domestic transportation moved up steadily from 1972 through 1980. During this period it increased 48.5% from 838.8 billion ton miles in 1972 to a peak of 1,245.3 billion ton miles in 1980.

Ton miles in transport then declined slightly and averaged 1,220 billion ton miles from 1981–1983. But then in 1984 transport ton miles dropped rather sharply to 1,180.2 billion ton miles, down 5.2% from the peak. It moved up slightly to 1,195.5 billion ton miles in 1985, due to an increase in crude oil transport. It fell off in 1986 to 1,187.8 billion ton miles as crude production fell. But then transport volume rebounded to 1,195.8 billion ton miles in 1987.

Crude oil transported constituted 60.5% of the total in 1980. This was up from 43.2% in 1972. It moved up slightly to 65.8% in 1985, slipped to 63.3% in 1986, and then back up to 64.2% in 1987. The sharp increase in crude oil ton miles is due to increased Alaskan production. The shifts in the level of product transport is related to the changing product demand levels.

Movement of crude oil has followed a different pattern than that for overall crude and petroleum products. Transport of crude oil

WORLD TANKER FLEET* BY AGE, 10,000 DWT AND OVER

(As at year end — in Th.DWT)

Year built	1974 & earlier		1975-1979		1980-1984		1985-1989		Total	
Size group DWT	No.	DWT	No.	DWT	No.	DWT	No.	DWT	No.	DWT
10,000/16,499	97	1,330.8	59	828.7	65	833.1	63	892.8	284	3,885.4
16,500/24,999	183	3,892.9	58	1,235.6	88	1,745.2	19	380.3	348	7,254.0
25,000/29,999	98	2,719.3	45	1,268.9	59	1,705.3	48	1,364.8	250	7,058.3
30,000/39,999	131	4,475.4	182	6,162.8	102	3,652.5	63	2,376.9	478	16,667.6
40,000/44,999	10	423.0	6	251.7	25	1,058.6	25	1,051.6	66	2,784.9
45,000/49,999	15	720.9	1	50.0	27	1,273.5	29	1,354.4	72	3,398.8
50,000/59,999	25	1,353.3	33	1,835.1	58	3,251.3	7	411.7	123	6,851.4
60,000/69,999	25	1,647.0	16	1,056.7	67	4,252.3	19	1,222.7	127	8,178.7
70,000/79,999	43	3,210.4	14	1,114.6	30	2,398.6	8	616.1	95	7,339.7
80,000/99,999	62	5,516.9	96	8,495.6	52	4,598.6	77	6,673.9	287	25,285.0
100,000/159,999	100	12,568.9	139	18,550.8	16	2,034.5	45	5,530.9	300	38,685.1
160,000/199,999	4	690.4	19	3,349.0	3	543.5	—	—	26	4,582.9
200,000/249,999	59	13,471.5	39	9,008.9	2	455.9	18	4,229.7	118	27,166.0
250,000/319,999	96	25,707.6	114	31,283.7	8	2,283.1	25	6,447.2	243	65,721.6
320,000/399,999	3	1,018.3	30	10,809.1	2	704.4	—	—	35	12,531.8
400,000 & over	—	—	23	10,170.7	—	—	—	—	23	10,170.7
Total	951	78,746.5	874	105,471.9	604	30,790.5	446	32,553.2	2,875	247,562.8
TOTAL WORLD†									2,975	250,441.1

*Only the Commercial Fleet is included. †Including government-owned tankers.
Note: Figures are individually rounded.
Source: OPEC Statistical Bulletin

moved up to a peak of 806.1 billion ton miles in 1983. It dropped to 748.4 billion ton miles in 1984 and then moved up to 786.2 billion ton miles in 1985. It fell to 751.3 billion ton miles in 1986 but then increased to 767.3 billion ton miles in 1987.

For crude oil carried in domestic transport, pipelines and water carriers accounted for 99.7% of total ton miles moved. This has not changed much during the past 15 years. Motor carriers and railroads carry a very small portion of the crude oil moved.

There has been a shift in crude transport from pipelines to water carriers. In 1977 pipelines carried 83.2% of the crude and water carriers 16.1%. Due to the increased volumes of crude moved long distances by water from Alaska, this shifted to 57.7% pipeline and 41.9% water carrier in 1978. In 1985 this had moved to 42.5% pipeline and 57.2% water carrier. In 1986 it was 55.1% water carrier and 44.6% pipeline. And in 1987 it was 55.2% water carrier and 44.5% pipelines.

The total volume of crude oil carried in transport by pipelines also fell. It was at a peak of 372.2 billion ton miles in 1979. It dropped to 332.4 billion ton miles in 1983. It has been moving up slowly since then. In 1987 it was back up to 341.5 billion ton miles. Water carrier crude oil volume hit a peak of 471.2 billion ton miles in 1983. It fell to 413.6 billion ton miles in 1986. It was up to 423.3 billion ton miles in 1987.

Total ton miles of petroleum products carried in domestic transport peaked in 1978, at 536.7 billion ton miles. That was the year of peak domestic demand. This dropped 409.3 billion ton miles in 1985, down 23.7%. It then moved back up to 436.5 billion ton miles in 1986 but slipped to 428.5 billion ton miles in 1987. The increase is a reflection of the increased demand, but the pattern of transport volumes is erratic.

Pipelines and water carriers accounted for 90.6% of the product transport in 1987. Motor carriers accounted for 6.7% and railroads 2.6%. Much of the short haul and smaller volumes are carried by motor carriers. Motor carriers and railroads also service areas where pipelines and water carriers do not or can not provide service.

TRADE MOVEMENTS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/89	1990 share of total %
	(1,000 b/d)												
Imports													
United States	6,735	5,950	5,040	4,990	5,380	5,065	6,045	6,245	7,240	8,019	8,026	+0.1	25.5
Western Europe	12,214	10,623	9,717	9,006	8,938	8,733	9,242	8,238	9,438	9,702	9,747	+ 0.5	31.0
Japan	4,985	4,460	4,155	4,145	4,305	4,045	4,140	4,125	4,412	4,549	4,802	+5.6	15.3
Rest of World	8,390	8,000	7,020	6,555	6,470	6,645	7,220	6,315	7,111	8,320	8,866	+ 6.6	28.2
TOTAL WORLD	**32,324**	**29,033**	**25,932**	**24,696**	**25,093**	**24,488**	**26,647**	**24,923**	**28,201**	**30,590**	**31,441**	**+ 2.8**	**100.0**
Exports													
United States	555	605	815	740	720	780	765	745	845	817	889	+ 8.8	2.8
Canada	445	455	485	545	655	685	675	630	890	944	955	+ 1.2	3.0
Latin America	3,885	4,380	4,135	4,065	4,100	3,565	3,800	3,035	3,246	3,511	3,754	+ 6.9	12.0
Middle East	17,510	14,605	11,660	10,355	9,845	9,340	10,880	10,315	11,842	13,389	14,212	+ 6.1	45.2
North Africa	2,820	2,175	2,145	2,180	2,290	2,416	2,515	2,435	2,598	2,415	2,604	+ 7.8	8.3
West Africa	2,475	1,730	1,500	1,425	1,670	1,765	1,980	1,880	2,022	2,319	2,248	− 3.1	7.1
Asia*	1,745	1,700	1,550	1,465	1,655	1,600	1,610	1,410	1,380	1,758	1,582	−10.0	5.0
U.S.S.R., C. Europe & China	2,394	2,573	2,612	2,996	3,208	3,288	3,402	3,243	4,136	3,796	3,259	−14.1	10.4
Rest of World	495	810	1,030	925	950	1,050	1,220	1,230	1,242	1,641	1,938	+18.1	6.2
TOTAL WORLD	**32,324**	**29,033**	**25,932**	**24,696**	**25,093**	**24,489**	**26,647**	**24,923**	**28,201**	**30,590**	**31,441**	**+ 2.8**	**100.0**

*Excluding China and Japan
Source: British Petroleum

Since the peak of transport of petroleum products in 1978, the pipeline volume has decreased slightly and the percentage has moved up considerably. The total pipeline volume was 236.1 billion ton miles in 1979. It dipped to 223.7 billion in 1983 and then bounced back to 235.1 billion in 1984. It moved up to 242.7 billion ton miles in 1986 and 245.3 billion ton miles in 1987. The relative volume increased from 44.2% in 1979 to 56.2% in 1985, 55.6% in 1986, and 57.2% in 1987.

The water carrier volume peaked in 1977 at 270.2 billion ton miles of petroleum products. It fell to 141.2 billion ton miles in 1985. It recovered slightly to 154.5 billion ton miles in 1986. But then it slipped to 143.2 billion ton miles in 1987.

The reduction of the import of residual fuel oil from U.S. Caribbean Island refineries was a major factor in this decline. The percentage of products carried by water carriers fell from 50.9% in 1977 to 34.5% in 1985, 34.5% in 1986, and 33.4% in 1987.

Almost all natural gas is transported by pipeline. The change in the volume of overall domestic production and consumption are major factors determining the transport level of natural gas. The location of production and consumption is also a major factor determining changes in natural gas transport.

The importation of natural gas can be a factor also. Changes in the volume and location of these imports are influence decisions concerning pipeline volume and location. Almost all imports are presently from Canada via pipeline. However there have been some imports of LNG from Algeria and Indonesia.

PIPELINES. Between 1973 and 1982, total U.S. pipeline mileage increased from 419,464 miles to 459,548 miles. This was an increase of 40,084 miles, 9.6%. Gas pipeline mileage increased from 248,773 miles to 286,999 miles, an increase of 38,226 miles. The increase in gas pipelines accounted for 95.4% of the increase in total pipeline mileage. Liquids pipeline mileage was 172,549 miles in 1982, up only 1.1% from 170,691 miles in 1973.

Total interstate pipeline mileage in the United States peaked in 1982 at 459,548 miles. That was also the year of peak natural gas pipeline mileage of 286,999 miles, 62.5% of total mileage. Liquids pipeline mileage

was 172,549 miles that year.

Total operating mileage fell sharply in 1984. However it rebounded in 1985 and has oscillated but remained close to 450,000 in 1986, 1987, and 1988. The latest year for which data is available is 1988. In that year total mileage was 451,838 miles, down 7,710 miles from the peak. Gas pipeline mileage in 1988 was 281,381 miles, down 5,618 miles from the peak. Liquids pipeline mileage was 170,457 miles, down 2,092 miles from 1982. The peak year for liquids pipeline mileage was 1976, with 174,072 miles. Although pipeline mileage is down from the peak in 1982, it was on the rise from 1984–1986. It moved up 19,864 miles during the 1984–1986 period. In 1987 it slipped again falling 3,945 miles. In 1988 it climbed again increasing 3,888 from 1987. In 1989, the last year that data is available, the total mileage fell 9,800 miles to 442,038 miles. The miles of interstate natural gas pipeline fell 7,980 miles to 273,401 miles. The total miles of interstate liquids pipeline in the United States fell 1,820 miles to 168,637 miles in 1990.

The change in total mileage does not reflect all total new construction. With changes in production and distribution patterns, some old pipelines are shut down each year. Therefore new construction includes more than just net additions. So these figures on changes in operating mileage can be a bit misleading with respect to total pipeline construction activity. Even when total mileage was declining, there was ongoing construction activity. New discoveries of crude oil and natural gas and changing distribution patterns for petroleum products and natural gas require an ever changing pipeline network. Pipelines are added to new or expanding producing areas and are shut down as areas are depleted. Population growth and movements, and changes in the level of economic activity, result in new requirements for new distribution pipelines.

WORLD LIQUID GAS CARRIER FLEET BY SIZE AND TYPE — 1989

(As at year end — In Th. Cubic Metres)

Size group	LPG No.	LPG Capacity	LNG No.	LNG Capacity	Total No.	Total Capacity
- Up to/ 999	100	68.5	—	—	100	68.5
1,000/ 1,999	205	284.1	1	1.1	206	285.2
2,000/ 4,999	148	452.1	5	12.5	153	464.6
5,000/ 9,999	72	482.0	1	5.0	73	487.0
10,000/19,999	92	707.7	—	—	92	707.7
20,000/39,999	28	769.6	6	182.9	34	952.5
40,000/59,999	22	1,166.3	6	252.9	28	1,419.2
60,000/99,999	54	4,106.8	11	848.9	65	4,955.7
100,000 & over	1	100.9	45	5,719.5	46	5,820.4
TOTAL WORLD	682	8,138.8	75	7,022.8	757	15,160.8

Note: Figures are individually rounded

Source: OPEC Statistical Bulletin

Recent increase in U.S. demand for crude oil has been coupled with the decline of domestic production. This has resulted in the sharp increase in importation of crude oil. The decline in U.S. production in some regions has resulted in a shortage of traditional supplies for some Midwest refineries. Recently there has been an increasing requirement to move imported crude oil inland to these refineries. This requirement for imported crude oil for inland refineries has resulted in the reversal of the flow of some pipelines. Instead of domestic production flowing south to Gulf Coast refineries, imported crude oil is now flowing north to Midwest refineries. The volumes of crude to be moved north will increase in the future and additional pipeline capacity may be needed.

CAPITAL SPENDING. The level of expenditures on new pipeline construction activities is quite significant. Pipeline expenditures are a representation of the industry's perception of future long-term needs. Many pipeline projects are of a long duration and do not have an impact on immediate needs. Therefore, the relative level of spending is a good leading inoicator of the expected changes in the level of activity in the oil and gas industry.

TOTAL CRUDE PETROLEUM AND PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude and products Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1974	847.7	506.0	59.69	297.0	35.04	29.0	3.42	15.7	1.85
1975	846.7	507.0	59.88	298.0	35.20	27.6	3.26	14.1	1.66
1976	867.7	515.0	59.35	306.9	35.37	32.5	3.75	13.3	1.53
1977	923.4	546.0	59.13	333.3	36.09	29.6	3.21	14.5	1.57
1978	1,160.2	585.8	50.49	530.6	45.73	30.6	2.65	13.2	1.14
1979	1,174.8	608.3	51.78	522.9	44.51	30.1	2.56	13.5	1.15
1980	1,245.3	588.2	47.24	617.8	49.61	26.8	2.15	12.5	1.00
1981	1,218.4	563.7	46.27	617.2	50.66	24.9	2.04	12.6	1.03
1982	1,218.2	565.7	46.44	616.9	50.64	22.7	1.86	12.9	1.06
1983	1,223.5	556.1	45.45	630.5	51.53	25.1	2.05	11.8	0.97
1984	1,180.2	568.1	48.14	570.7	48.36	29.2	2.47	12.2	1.03
1985	1,195.5	564.3	47.20	590.4	49.39	28.7	2.40	12.1	1.01
1986	1,187.8	577.9	48.65	568.1	47.83	29.7	2.50	12.1	1.02
1987	1,195.8	586.8	49.08	566.5	47.37	30.4	2.54	12.1	1.01
1988	1,188.1	601.1	50.59	543.7	45.76	30.5	2.57	12.8	1.08
1989	1,094.2	584.2	53.39	466.2	42.61	30.4	2.78	13.4	1.22

TOTAL CRUDE PETROLEUM CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1974	358.9	303.0	84.4	53.0	14.3	1.3	0.4	1.6	0.4
1975	331.5	288.0	86.9	40.6	12.2	1.4	0.4	1.5	0.5
1976	343.8	303.0	88.1	37.8	11.0	2.1	0.6	0.9	0.3
1977	392.5	326.6	83.2	63.1	16.1	2.0	0.5	0.8	0.2
1978	623.5	359.5	57.7	261.3	41.9	2.0	0.3	0.7	0.1
1979	640.6	372.2	58.1	265.5	41.4	2.3	0.4	0.6	0.1
1980	753.0	362.6	48.2	387.4	51.4	2.5	0.3	0.5	0.1
1981	740.7	333.1	45.0	404.9	54.6	2.2	0.3	0.5	0.1
1982	770.2	335.1	43.5	432.7	56.2	2.0	0.2	0.4	0.1
1983	806.1	332.4	41.2	471.2	58.5	2.0	0.2	0.5	0.1
1984	748.4	333.0	44.5	412.6	55.1	2.2	0.3	0.6	0.1
1985	786.2	334.4	42.5	449.2	57.2	1.8	0.2	0.8	0.1
1986	751.3	335.2	44.6	413.6	55.1	1.7	0.2	0.8	0.1
1987	767.3	341.5	44.5	423.3	55.2	1.6	0.2	0.9	0.1
1988	739.9	350.7	47.4	386.8	52.3	1.6	0.2	0.8	0.1
1989	653.0	338.7	51.9	312.2	47.8	1.6	0.2	0.5	0.1

TOTAL PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total petroleum products Ton miles	PIPELINES Ton miles	PIPELINES Percent of total	WATER CARRIERS Ton miles	WATER CARRIERS Percent of total	MOTOR CARRIERS* Ton miles	MOTOR CARRIERS* Percent of total	RAILROADS Ton miles	RAILROADS Percent of total
1974	488.8	203.0	41.5	244.0	49.9	27.7	5.7	14.1	2.9
1975	515.2	219.0	42.5	257.4	50.0	26.2	5.1	12.6	2.4
1976	523.9	212.0	40.5	269.1	51.4	30.4	5.8	12.4	2.3
1977	530.9	219.4	41.3	270.2	50.9	27.6	5.2	13.7	2.6
1978	536.7	226.3	42.2	269.3	50.2	28.6	5.3	12.5	2.3
1979	534.2	236.1	44.2	257.4	48.2	27.8	5.2	12.9	2.4
1980	492.3	225.6	45.8	230.4	46.8	24.3	5.0	12.0	2.4
1981	477.7	230.6	48.3	212.3	44.4	22.7	4.8	12.1	2.5
1982	448.0	230.6	51.5	184.2	41.1	20.7	4.6	12.5	2.8
1983	417.4	223.7	53.6	159.3	38.2	23.1	5.5	11.3	2.7
1984	431.8	235.1	54.4	158.1	36.6	27.0	6.3	11.6	2.7
1985	409.3	229.9	56.2	141.2	34.5	26.9	6.6	11.3	2.7
1986	436.5	242.7	55.6	154.5	35.4	28.0	6.4	11.3	2.6
1987	428.5	245.3	57.3	143.2	33.4	28.8	6.7	11.2	2.6
1988	448.2	250.4	55.9	156.9	35.0	28.9	6.4	12.0	2.7
1989	441.2	245.5	55.7	154.0	34.9	28.8	6.5	12.9	2.9

*Estimate

Source: Association of Oil Pipelines

TRANSPORTATION

Industry capital expenditures for transportation requirements is spread over natural gas pipelines, crude oil pipelines, petroleum product pipelines, water transport vessels, railroad cars, and motor carriers. However, the vast majority of the spending is for pipeline construction.

Capital spending on total U.S. pipeline construction increased from $672 million in 1972 to $7,390 million in 1982, an increase of 999.7% during the 10 years. Spending on natural gas pipelines increased from $578 million in 1972 to $6,070 million in 1982, 950.2%. Crude and product pipeline outlays in 1982 were $1,320 million, up 1,304.3% from $94 million in 1972. Outlays for crude and product pipelines have been more volatile, reaching a peak of $2,949 million in 1976 when the Alaskan pipeline was under construction. After that project was completed, the highest level of spending was reached in 1983 at $2,456 million.

Pipeline spending fell following the downturn in demand and the drop in prices. Spending on crude oil pipelines, petroleum product pipelines, and natural gas pipelines all dropped sharply. Total pipeline spending fell to $1,744 million in 1986, down 76.4% from 1982. Of the 1986 total, $1,309 million was for natural gas pipelines and $435 million for crude and products pipelines. Natural gas pipeline spending was down 78.4% from the 1982 level.

There was a shift in the trend in 1987. Total pipeline spending moved up to $2,289 million in 1987. Natural gas pipeline spending increased to $1,556 million, and crude and product pipeline spending moved up to $733 million. Outlays slipped a bit in 1988 to $2,059 million. Natural gas pipeline spending moved up to $1,659 million, and crude and product pipeline spending fell to $400 million. But total spending slipped again in 1989, falling to $1,420 million for total pipeline construction. Natural gas pipeline capital expenditures fell to only $969 million. Crude and product pipeline construction moved up slightly to $451 million.

In 1991 capital expenditures on natural gas pipelines jumped sharply, increasing 104.5% to $1,982 million. This resurgence reflects the growing importance of natural gas as a clean energy source during the next several years. Spending in 1990 on crude and product pipelines also moved, increasing 10.9% to $500 million. This reflected changing supply patterns for U.S. refineries. Total pipeline capital expenditures in 1990 were $2,482 million, up 74.8%, an increase of $1,062 million from 1989.

Plans for 1991 capital spending show another sharp increase in total spending to $3,150 million, due to a sharp increase in natural gas pipeline outlays. Total spending is planned to be up $668 million, 26.9% above 1990.

Spending on natural gas pipelines will move up 39.8% in 1991 to $2,770 million, an increase of $788 million. Capital spending on crude oil and product pipelines will fall, dropping $120 million to $380 million.

Oceangoing tankers for the transportation of crude also represent huge investments. During the periods of a declining market, with substantially reduced demand, and therefore reduced import/export volumes, there was a massive surplus of tanker tonnage. The domestic industry also uses water carriers for a substantial part of crude oil and product transport. With reduced domestic demand, transport volumes dropped and this reduced the need for additional investment in tankers.

Investment for other land transport and inland water transport represents smaller outlays and is less volatile. A reduction in expenditures due to lower demand levels was offset somewhat by increased expenditures due to changing patterns of distribution.

When demand was rising, capital expenditures on other modes of transport also moved up rapidly, increasing from $175 million in 1972 to $895 million in 1981, up 411.4%. When demand started to decline, outlays also started to fall. Investment in this sector dropped to $310 million in 1987. This was a decline of 65.4%. Investment rebounded in 1988 to $416 million. Investment continued to move up with increased imports, increasing to $498 million in 1989 and $647 million in 1990.

Plans for 1991 are for industry outlays of $995 million, up 53.8% from 1990 and up 221% from 1987. This is related to the rapid increase in demand for petroleum products and sharp increase in imports.

TANKERS. A large portion of the outlays for other transport are for oceangoing tankers for crude transport. And spending for these tankers moves with the level of worldwide crude and product import/export trade.

When imports fell sharply, this had a negative impact on the tanker industry. The worldwide tanker industry was severely depressed due to the sharp drop in trade, as demand fell following the crude price hike.

The tanker fleet fell from a peak of 332.5 million deadweight tons (dwt) in 1977 to 239.4 million tons in 1987. This was a drop of 28%. And much of the existing tonnage was idle or under utilized. However, the reduction seemed to hit bottom in 1987. The small size of the fleet reduction in 1987, only 1.6 million dwt, was an indication that the size of the tanker fleet was in better balance with demand.

The adjustment took the shape of eliminating redundant VLCC tankers. They are used mainly for long-distance transport and the long-haul volumes of crude from the Persian Gulf to the United States were cut sharply with the drop in imports. The industry is now concentrating on smaller and more flexible tankers. To hold down losses, many excess tankers were converted for other uses, such as offshore storage.

The development of the North Sea oil fields also had a substantial impact on the tanker industry. As these fields developed, Europe was transformed from long-haul tanker trade to short-haul. In the early and mid-1970s, Europe relied primarily on long-haul oil from the Persian Gulf. This oil moved in VLCC tankers through the Straits of Hormuz and around the Cape of Good Hope. With the North Sea fields, many of these tankers were no longer needed.

With increased worldwide demand and increased petroleum import/export trade, the tanker fleet began to move back up in 1988, 1989, and 1990. The fleet moved up to 243.5 million dwt at end 1988, to 249.9 million dwt at end 1989 and to 250.4 million dwt at end 1990. This is an indication that the picture is changing for the tanker fleet. Petroleum demand and imports are increasing worldwide. The increased import requirements are most dramatic for the United States. And the U.S. import requirements appear to be the real key to the change in tanker needs.

Worldwide trade of oil fell off sharply from a peak of 35.35 million bbl/d in 1979 to a recent low of 24.12 million bbl/d in 1985. This was a decline of 31.8%, a drop of 11.23 million bbl/d in world trade volumes. But this has also been rebounding since the decline in crude oil and product prices and the increase in petroleum product demand. The worldwide trade volume moved up to 26.265 million bbl/d in 1986 on the strength of increased demand and increased U.S. imports. It fell to 24.923 million bbl/d in 1987 when crude oil prices rebounded and trade slowed.

In 1988, with lower oil, the trade volume jumped to 28.201 million bbl/d. It continued up to 30.590 million bbl/d in 1989 and 31.441 million bbl/d in 1990. It increased 6.518

million bbl/d, 26.2%, during three years. A substantial portion of this increase in traffic was due to the increase in U.S. imports.

OUTLOOK

The outcome of the conflict in the Middle East has resulted in a relatively stable current oil market. This has happened even though production capacity in Kuwait has been temporarily destroyed and the embargo remains on exports of oil from Iraq. These events have temporarily removed 4.2–4.5 million bbl/d of supply from the world oil market. Prices have been stabilized even though there is very little excess crude oil production capacity in the world. OPEC's ability to manage supply to meet current demand has been enhanced by the elimination of production from these two major producers. Another favorable outcome for the industry is that prices have been stabilized at a level higher than before the conflict.

Another outcome from the conflict was expansion of production capacity in other countries. During the conflict several countries with substantial reserves boosted their output to meet the shortfall from Iraq and Kuwait. And these and other countries have also announced plans to continue to expand production in future years.

In addition to these expansion plans, production from both Iraq and Kuwait is expected to reenter the market during the next couple of years. Along with the expansions, this will add up to a significant volume of additional crude oil capacity available to the world oil market. Capacity is expected to move up faster than demand during the forecast period, particularly during the first few years of the period. This will increase the volume of worldwide excess capacity.

The additional excess capacity is expected to work to put additional downward pressure on prices. With additional capacity available, it is substantially more difficult to balance supply with current demand and to stabilize prices. Prices are expected to move up during the forecast period, but the rate of increase will be lower than the rate of inflation. This will stimulate energy and oil consumption during the forecast period.

Lower oil prices will also tend to reduce the investment in oil and gas production in high cost areas. As a result, non-OPEC production will peak and then fall during the forecast period. This will increase worldwide dependency upon oil from OPEC and the Middle East. Increased imports into the industrial and rapidly developing areas will have to move longer distances. Therefore increases in worldwide demand for oil will mean increases in transport requirements and increases in capital expenditures for transport.

Concern for the environment also may lead to increased requirements for industry transportation. Natural gas is being considered as an energy source that is less polluting and abundantly available. Increased consumption of natural gas will increase the requirements for pipelines and compressor stations to carry natural gas. There also will be investment in special processing equipment and tankers to carry LNG.

In summary, a continued increase in economic activity will boost the demand for energy and for natural gas and petroleum products in a variety of worldwide areas. The consuming areas are not generally the areas with the huge energy reserves and production. Therefore, the consumption of increasing volumes of crude oil, natural gas and petroleum products will require a great deal of additional transport of many types.

Base Scenario — Crude oil prices will remain at a slightly elevated level throughout 1991 and into 1992. Economic activity worldwide will begin to move up as the U.S. pulls out of its recession. With improved economic growth, energy demand worldwide and in the United States will again start to move up. This will also translate into increased demand for petroleum products both worldwide and in the United States. Worldwide oil demand is projected to move up 405,000 bbl/d in 1992. U.S. oil demand will move up 275,000 bbl/d. U.S. imports are projected to increase 450,000 bbl/d to 8.160 million bbl/d. Worldwide petroleum trade will increase 640,000 bbl/d. Increased U.S. imports will account for 70.3% of the increase in worldwide trade.

In 1993 when production from Iraq and Kuwait is available in the market in large volumes and when increased capacity in other countries is available, prices will fall. This will give a boost to economic growth and energy consumption. Prices will move up during the remainder of the forecast period but not fast enough to dampen economic, energy, and product demand growth. Worldwide oil demand will move up to 70.475 million bbl/d in 1996. This is an increase of 6.2 million bbl/d during the forecast period. U.S. demand will move up to 18.175 million bbl/d in 1996, an increase of 1.48 million bbl/d. U.S. oil imports will move up to 9.86 million bbl/d in 1996, an increase of 2.15 million bbl/d from the level in 1991. The volume of petroleum in world trade will increase 17.4% to 36.35 million bbl/d, up 5.4 million bbl/d from 1991. The increase in U.S. imports will account for 39.8% of the increase.

The increase in economic activity during the forecast period will result in increased energy consumption. One of the major sources of energy that is expected to grow substantially is natural gas. Natural gas consumption will be on the increase worldwide, and U.S. domestic demand will be rising. U.S. consumption of natural gas is projected to be up 8.8% in 1996, an increase of 1,655 bcf. Domestic production is projected to be up 5.7%, an increase of 1,040 bcf, and imports are projected to be up 40.1%, an increase of 630 bcf.

During the forecast period, worldwide natural gas trade is expected to move up 20.6% along with worldwide demand for energy. Worldwide natural gas trade will increase 1,730 bcf to 10,130 bcf in 1996. Worldwide LNG trade is projected to move up 40.9%. Worldwide LNG trade is expected to move up 1,150 bcf to 3,960 bcf in 1996.

A substantial part of the increase in consumption of petroleum products will take place in the industrial countries. Many of these countries have either low or declining rates of domestic production. There also will be substantial demand increases in developing countries that have low levels of oil production. These needs can only be met by imported crude oil or petroleum products. Therefore, worldwide import/export petroleum trade will move up much faster than demand. The increase in U.S. imports will be a major part of the increase in trade. And because of the distance required to bring imports to the United States, it will account for a much larger proportion of the increased transport requirement.

This large increase in crude oil and petroleum product trade will require additional transport. There will be a substantial increase in requirements for oceangoing vessels to handle the increased import/export trade. With the increased demand for natural gas, there will be increased demand for LNG tankers also. In addition, there will be increased requirements for surface transport to move crude and products to the proper locations for refining or consumption. And there will be a significant increase in demand for pipeline capacity. Additional pipelines will be required

to move crude oil, petroleum products, and natural gas.

These increased volumes will require additional investment in transport during the forecast period. A lot of that investment will be in new pipeline construction.

Total U.S. capital expenditures for new pipeline construction is expected to increase 18.1% during the forecast period to $3,720 million in 1996. This is an increase of $570 million in the level of annual spending, as compared to 1991. Outlays for natural gas pipelines will increase 13.4%, up $370 million to $3,140 million in 1996. Crude and product pipeline construction will increase $200 million to $580 million in 1996. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on the level of pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. Increased demand will call for increased transport of products to areas of consumption. Increased worldwide trade will call for additional oceangoing tankers. Capital spending for other transport will move up 38.7% to $1,380 million in 1996. This is an increase of $385 million in the level of annual investment.

U.S. pipeline construction activity and investment may not return to the boom levels of 1981–1983, but it is obvious that a substantial level of new construction is planned. The pipeline industry has been required to change substantially to adjust to changing expectations for the industry and changing requirements for pipeline transport. They will be required to adjust again. Demand for natural gas and crude oil are expected to increase during the forecast period, and that will require additional pipelines.

The latest survey of pipeline construction plans shows an additional 29,638 miles of pipeline to be constructed in the world in 1991 and the years after. This is construction planned in all world areas but excluding the former communist countries. A total of 6,753 miles is planned for the United States and 22,885 miles outside the United States. This recent survey shows 22.8% of the pipeline construction planned for the United States. In 1987 this survey showed 69.8% of the construction planned for the United States. This is a good indication of the industry shift to non-U.S. production activities—to the areas with large reserves and low cost production.

The growing worldwide importance of the natural gas industry is reflected in the 18,284 miles of new gas pipeline planned. Of this total, 6,071 miles is planned for the United States and 12,213 miles outside the United States. Canadian plans are for an additional 4,000 miles. Much of this is to supply export gas for the U.S. market. Plans for Western Europe call for construction of 3,096 miles of gas pipelines. In the Asia-Pacific countries, plans are for 1,640 miles. Substantial mileage is planned for all of the areas. Plans for Latin America are for an additional 1,827 miles of gas pipeline, Middle East 880 miles of natural gas pipelines, and Africa 770 miles.

A total of 5,294 miles of new crude pipeline is planned with 391 miles in the United States and 4,903 miles of crude oil pipeline outside the United States. There are 1,794 miles planned in Africa. This is followed by the Middle East at 1,340 miles. Asia-Pacific plans call for 699 miles, Latin America 470 miles, Western Europe 320 miles, and Canada 280 miles.

Total product pipeline mileage planned to be constructed is 6,060 miles, with 291 miles in the United States and 5,769 miles outside the United States. Plans call for 2,924 miles in Asia Pacific, 1,786 miles in Latin America, and 1,025 miles in Western Europe. In addition, there will be 34 miles in Africa.

The United States leads the way in construction plans for natural gas pipelines, Africa leads for crude pipelines, and Asia-Pacific leads for product pipelines. Total U.S. pipeline miles planned is 6,753 miles. Plans are for 4,280 miles in Canada, almost all gas pipeline. Much of this is for export to the U.S. market. Plans for Western Europe call for 4,441 miles of pipeline. Asia-Pacific plans are for 5,263 miles. In Latin America plans are for 4,083 miles. In Africa plans call for 2,598 miles, and in the Middle East 2,220 miles of pipeline are planned.

All of these changes and additions are reflected in the projected increase in transport capital expenditures during the 1991–1996 period.

TRANSPORTATION

KEYS TO THE FUTURE

1. U.S. and worldwide demand for petroleum products, crude oil, and natural gas will increase during the forecast period. Demand growth will be stimulated by worldwide economic growth, particularly when the economies of Eastern Europe and the USSR begin to recover. Increased production capacity worldwide will tend to limit price increase. Crude oil prices will slip in 1992 and 1993 but then move up during the latter part of the forecast period at a slower rate than inflation. The modest prices will stimulate demand for crude oil. Prices for natural gas will move up more rapidly as demand increases. However the desirability of natural gas as an environmentally friendlier fuel will stimulate demand.

2. The increased demand will result in a substantial increase in the worldwide petroleum import/export trade. Declining U.S. crude production will increase the volume that must be supplied via worldwide import/export trade. Import/export trade volume will continue to move up.

3. Transport requirements in the United States will change markedly during the forecast period. U.S. demand for petroleum products and natural gas will move up during the 1992–1996 forecast period. This will increase the volume in transport. Growth in demand for petroleum products and demand for natural gas will move up during the forecast period and put pressure on transport requirements.

4. All of these increases in consumption, production, and trade will boost requirements for all types of transport: tankers, pipelines, and motor and rail transport.

5. The increased transport requirements will result in increased capital spending on transport facilities and equipment throughout the forecast period. Annual U.S. outlays will move up throughout the forecast period. The level of investment will be related to anticipated future demand and the level of available industry funds. Total spending for transport in 1996 will be up 23% from the 1991 level.

THE OUTLOOK — TRANSPORTATION

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
CAPITAL SPENDING - U.S.									
(million $)									
Natural gas pipelines	1,982	2,770	2,480	2,640	2,810	2,970	3,140	+370	+13.4
Crude and product pipelines	500	380	500	520	540	560	580	+200	+52.6
Other transport	647	995	1,020	1,120	1,225	1,325	1,380	+385	+38.7
Total transportation	**3,129**	**4,145**	**4,000**	**4,280**	**4,575**	**4,855**	**5,100**	**+955**	**+23.0**
U.S. CRUDE IMPORTS	5,894	5,925	6,205	6,595	6,890	7,215	7,515	+1,590	+26.8
Industry and SPR crude									
(thousand barrels/day)									
U.S. PRODUCT IMPORTS									
(thousand barrels/day)	2,124	1,800	2,000	2,100	2,200	2,300	2,400	+600	+ 33.3
WORLD PETROLEUM TRADE									
(thousand barrels/day)	31,441	30,950	31,590	32,900	34,280	35,330	36,350	+5,400	+17.4
WORLD NATURAL GAS TRADE	8,246	8,400	8,610	8,940	9,340	9,740	10,130	+1,730	+20.6
IMPORT/EXPORT									
(billion cubic feet)									
WORLD LNG TRADE	2,553	2,810	2,950	3,170	3,450	9,740	3,960	+1,150	+40.9
(billion cubic feet)									

OUTLOOK 2000 — TRANSPORTATION

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
CAPITAL SPENDING — U.S.									
(million $)									
Natural gas pipelines	1,982	2,970	3,790	+988	+820	+1,808	+49.8	+27.6	+91.2
Crude and product pipelines	500	560	670	+ 60	+110	+170	+12.0	+19.6	+34.0
Other transport	647	1,325	1,970	+678	+645	+1,323	+104.8	+48.7	+204.5
Total Transportation	**3,129**	**4,855**	**6,430**	**+1,726**	**+1,575**	**+3,301**	**+55.2**	**+32.4**	**+105.5**
U.S. CRUDE IMPORTS	5,894	7,215	8,190	+1,321	+975	+2,296	+22.4	+13.5	+39.0
Industry and SPR crude									
(thousand barrels/day)									
U.S. PRODUCT IMPORTS	2,124	2,300	2,890	+176	+590	+766	+8.3	+25.7	+36.1
(thousand barrels/day)									
WORLD PETROLEUM TRADE	31,441	35,330	38,780	+3,889	+3,450	+7,339	+12.4	+9.8	+23.3
(thousand barrels/day)									
WORLD NATURAL GAS TRADE	8,246	9,740	12,890	+1,494	+3,150	+4,644	+18.1	+32.3	+56.3
IMPORT/EXPORT									
(billion cubic feet)									
WORLD LNG TRADE	2,553	3,740	4,550	+1,187	+810	+1,997	+46.5	+21.7	+78.2
(billion cubic feet)									

NATURAL GAS

Events that are unfolding worldwide with regard to economic growth and energy consumption seem to guarantee a favorable outlook for natural gas. The successful resolution of the conflict in the Middle East has tended to stabilize the world oil and energy markets. And looking to the future it appears that increases in capacity will help to hold down energy prices and to encourage consumption.

UNITED STATES NATURAL GAS SUPPLY AND DEMAND

	1975	1980	1984	1986	1988	1989	1990
				(Billion cu ft)			
Marketed production	20,109	20,180	18,230	16,791	17,841	18,029	18,469
Supplemental gas	0	155	110	113	101	107	105
Imports	953	985	843	750	1,294	1,382	1,512
Losses (including extraction)	(1,107)	(1,417)	(980)	(1,227)	(1,192)	(934)	(666)
Total supply	**19,955**	**19,903**	**18,203**	**16,427**	**18,044**	**18,584**	**19,420**
Exports	73	49	55	61	74	107	99
Stock change	344	(23)	197	145	(60)	(322)	518
Domestic demand	**19,538**	**19,877**	**17,951**	**16,221**	**18,030**	**18,799**	**18,803**
				Sector demand (Trillion BTU)			
Residential & commercial	7,581	7,540	7,292	6,825	7,513	7,720	7,198
Industrial	8,532	8,394	7,448	6,690	7,696	8,123	8,709
Transportation	595	650	545	499	632	649	590
Electric utility	3,240	3,810	3,220	2,691	2,709	2,882	2,881
Total	**19,948**	**20,394**	**18,505**	**16,705**	**18,550**	**19,374**	**19,378**

Source: Energy Information Administration

The growing worldwide concern for the environment is also very favorable for natural gas. As pressure mounts to reduce environmental pollution, there will be a turn toward natural gas. This will particularly be true during the transition phase while the search goes on for new technologies that will reduce or eliminate the pollution from other fossil fuels. Increased demand for natural gas should remove some of the excess capacity and allow natural gas prices to move up. In addition, the concern for the environment will possibly enable gas to accrue a slight premium as a clean burning fuel.

Over the past few years there has been a great deal of optimism expressed about the future of the worldwide and U.S. natural gas industries. That optimism is based upon the future need for an abundant, efficient, clean burning, non-polluting fuel to power future economic growth in the United States and elsewhere.

Activity in the upstream sector of the U.S. natural gas industry has been depressed this year due primarily to low natural gas prices. Prices have been depressed because of the increased volume of gas available. Imports from Canada have increased substantially, and U.S. producers have attempted to move gas based on price competition. In addition, demand growth has been held down by the economic recession in the United States. However this may actually represent a turning point in the industry. Consumption of natural gas has been moving up in recent years, and this is expected to accelerate due to electric utility fuel requirements and environmental regulations. Actually, it now appears that the industry could be poised for a period of sustained growth.

The U.S. natural gas industry lagged behind other sectors of the overall energy industry in adjusting to the volatile price changes of the late 1970s and 1980s. The slow adjustment to the price swings had an adverse impact on the natural gas industry. Natural gas lost market share in the energy business to competing fuels and this resulted in a drop in consumption of natural gas.

Prices and demand for energy have exhibited a great deal of volatility over the recent past. And structural changes, such as multifuel capacity and conservation programs, have increased the level of competition in the energy business. Faced with the substantial volatility and increased competition, it is necessary to be able to adjust rapidly to changing conditions in order to retain market share.

There are two major problem areas

that have confronted the natural gas industry and made the adjustment process more difficult. First there are the myriad of government regulations and controls to contend with. Secondly there is the structure of the industry and the changing relationship between producers, pipeline companies, and consumers.

Government regulation of the natural gas industry has been a major impediment to its ability to adjust to changing conditions and compete effectively. Government controls and regulations tend to distort the economics and interfere with the market mechanism. Government price controls have not allowed the market the self correcting mechanism that would enable rapid movement to demand and supply equilibrium at a market clearing price.

The long-term contractual arrangements that were, in the past, an integral part of the industry trading operation also proved to be a problem area when rapid price adjustment was required. Resolving that problem prevented the industry from concentrating resources and energy on resolving other problems facing the industry.

In addition, the natural gas industry has had to contend with the "gas bubble." The "gas bubble" is the natural gas industry's excess gas deliverability. It is comparable to OPEC's excess capacity, and it also puts downward pressure on prices. The gas bubble developed because demand fell sharply due to higher prices, and the industry was not able to adjust rapidly to the change. But some analysts contend that the industry has always had a gas bubble. It is the nature of the business to search for reserves well in advance of expected demand. And new reserves are often found in large volumes. Therefore the tendency is generally for the supply to far exceed the demand at any moment in time. However, if the gas bubble has been reduced to a level that will enable prices to move up to an economical level, then there will be a boost in industry activity in the future. Some experts believe the gas bubble has already disappeared. That would be a major boost to gas prices.

Natural gas finds itself in a very competitive energy market. In order to try to retain markets, the natural gas industry will have to be aggressive in marketing and flexible in pricing. Prices will have to be adjusted quickly to meet the competition from other fuels and changing seasonal demand patterns. One thing that could help greatly would be the elimination of confusing and inefficient government controls. Returning natural gas to a more market-oriented structure would lead quickly to a stronger, more efficient industry. It appears that the objective is to create a more market responsive industry in the future.

NATURAL GAS PROCESSING AND LIQUIDS PRODUCTION

	Gross gas production (Billion cu ft)	Gas processed (Billion cu ft)	Percent processed	Natural gas liquids: Gallons per Mcf of gas processed	Natural gas liquids: Liquids produced (000 b/d)
1970	23,786	18,509	77.8	1.376	1,661
1971	24,088	19,252	79.9	1.348	1,693
1972	24,016	19,906	82.9	1.347	1,744
1973	24,067	19,679	81.8	1.353	1,737
1974	22,850	18,684	81.8	1.386	1,689
1975	21,104	17,748	84.1	1.410	1,632
1976	20,944	17,718	84.6	1.388	1,604
1977	21,097	17,570	83.2	1.400	1,618
1978	21,309	17,012	79.8	1.381	1,567
1979	21,883	16,400	75.0	1.481	1,585
1980	21,870	15,750	72.0	1.537	1,576
1981	21,587	14,817	68.6	1.664	1,609
1982	20,210	14,164	70.1	1.678	1,550
1983	18,597	13,173	70.8	1.814	1,559
1984	20,192	13,946	69.1	1.792	1,630
1985	19,534	14,145	72.4	1.744	1,609
1986	19,063	13,985	73.4	1.700	1,551
1987	20,056	15,073	76.1	1.622	1,595
1988	20,922	15,274	73.0	1.631	1,625
1989	21,009	15,606	74.3	1.519	1,546
1990	21,345	16,060	75.2	1.488	1,559

Source: Oil & Gas Journal and Energy Information Administration

REVIEW

NATURAL GAS DELIVERABILITY. During the first half of the 1980s, natural gas prices moved up very quickly and quite high. This

U.S. GAS PRODUCTION AND RESERVES

	1973	1977	1979	1980	1981	1983	1984	1985	1986	1987	1988	1989	1990	% change 90/73
	(Billion cu ft)													
Marketed production:														
Texas	8,514	7,051	7,175	7,116	6,910	5,939	6,185	6,053	6,152	6,126	6,286	6,241	6,352	−25.4
Louisiana	8,242	7,215	7,266	6,940	6,780	5,332	5,825	5,013	4,895	5,123	5,180	5,078	5,238	−36.4
Others	5,891	5,759	6,030	6,124	6,266	5,551	6,220	6,132	5,744	6,100	6,375	6,710	6,879	+16.8
Total U.S.	**22,648**	**20,025**	**20,471**	**20,180**	**19,956**	**16,822**	**18,230**	**17,198**	**16,791**	**17,349**	**17,841**	**18,029**	**18,469**	**−18.5**
	(Billion cu ft)													
Reserves:														
Total U.S.	249,950	208,878	194,917	199,021	201,730	200,247	197,463	193,369	191,586	187,211,	168,024	167,116	166,208	−33.5
	(Years)													
Reserves/production ratio:														
Total U.S.	11.04	10.43	9.52	9.86	10.11	11.90	10.83	11.24	11.41	10.79	9.42	9.27	9.00	

Source: American Petroleum Institute; Energy Information Administration

had an unsettling impact on the natural gas industry. Prior to the jump in prices, demand for natural gas moved up or down with movements in the level of economic activity. Natural gas was priced so that it held an advantage over competing fuels in certain key sectors of the economy and/or areas of the country. This enabled natural gas to maintain a base demand load that supported industry activity, while the industry attempted to expand into other areas and markets.

Natural gas prices followed other energy prices and moved up slowly in the early 1970s. As other energy prices moved up at an accelerated pace, natural gas prices trailed but followed the same upward path. On the supply side, higher natural gas prices stimulated exploration and drilling for natural gas. And as a result, natural gas deliverability increased. At the same time, on the demand side, higher prices led to conservation and increased competition from competing fuels. And demand for natural gas moved lower.

Although other energy prices such as crude oil started falling in 1981, natural gas prices continued to move up until 1984. Therefore at the higher prices, natural gas faced even greater competition when oil prices started to slump. The price advantage that natural gas held in certain sectors was diminished. Natural gas lost some base load to conservation and still more to other fuels as users switched to lower cost fuels.

These changes in the market resulted in the development of a substantial "gas bubble" with available deliverable supply much greater than demand. Surplus deliverability was in excess of 20% in 1983. At that time, dry gas deliverability was estimated at around 20,200 bcf. And U.S. dry gas production was only 16,033 bcf. This left a surplus of 4,167 bcf.

The U.S. deliverability surplus has been reduced in recent years. The drop was primarily due to a decline in deliverability, but demand has also been moving back up. Dry gas deliverability in 1987 was estimated at 18,600 bcf. Estimated deliverability fell to 18,000 bcf in 1988 and to 17,500 bcf in 1989. At the same time there was an increase in dry gas production to 16,536 bcf in 1987, 17,026 bcf in 1988, 17,245 bcf in 1989, and 17,609 bcf in 1990. The production increases also have helped to reduce the surplus. The result of these moves has been a drop in the deliverability surplus to an estimated 2,064 bcf in 1987, 1,008 bcf in 1988, and only 385 bcf in 1989. This would indicate that the gap has been closed. However, the rapid increase in imports has changed the supply/demand balance substantially. This is pointed out in the section on supply.

PRICES. Changing natural gas and other energy prices have been a major factor affecting the natural gas industry during the past 15 years.

During the 10-year period 1973–1982, the average wellhead price of natural gas went up 1,118.2% from $0.22/mcf in 1973 to $2.46/mcf in 1982. That is an average annual increase of 30.8%. During this period the relationship between crude oil and natural gas prices changed markedly. The cost of natural gas relative to crude oil increased about 50%. As a result, natural gas lost some competitive advantage and began to lose share of the energy market.

Natural gas demand began to fall in 1981 and 1982. But even in the face of falling demand, prices continued to move up throughout 1981 and 1982. Long-term contracts, entered into when the outlook was for a future natural gas shortage, continued to push up prices. Because of the take-or-pay provisions in most of these contracts, when demand began to fall it became advantageous for the pipelines purchasing gas to continue to take high-priced gas and curtail acceptance of the lower-priced gas. This aggravated the problem and drove the prices higher.

Even though the price of crude oil and heavy fuel oil was falling and demand for natural gas was declining, the price of natural gas continued to move up in 1983 and 1984. But price increases were somewhat more moderate during 1983 and 1984. The average wellhead price moved up 5.3% in 1983 to $2.59/mcf and up a modest 2.7% in 1984 to $2.66/mcf. Over the entire span of 1974 to the peak price year of 1984, the price increased $2.44/mcf.

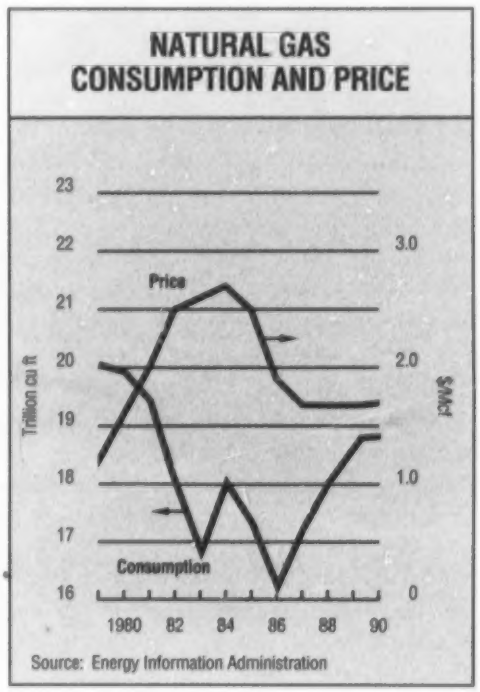
During that same period, the price paid for natural gas by electric utility plants increased $3.37/mcf from $0.35/mcf in 1973 to $3.72/mcf in 1984. The residential price

MARKETED PRODUCTION OF NATURAL GAS BY STATES*

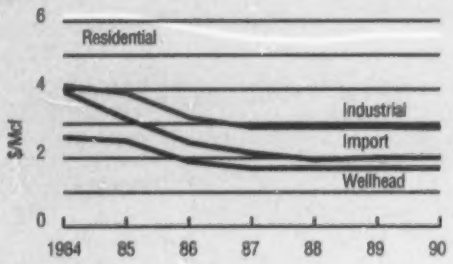
State	1984	1985	1986	1987	1988	1989	1990
	(Billion cu ft)						
Alabama	101.8	107.3	107.2	117.2	129.5	128.4	135.3
Alaska	289.1	321.3	304.8	359.8	378.6	393.7	402.6
Arkansas	135.2	155.1	131.1	141.2	166.6	174.2	187.1
California	476.3	491.3	462.2	424.6	399.7	362.9	355.2
Colorado	173.3	178.2	163.7	164.6	191.5	216.7	220.2
Florida	12.6	10.5	8.8	8.3	7.5	7.5	6.9
Kansas	466.0	512.9	465.7	457.1	576.3	587.2	558.3
Louisiana	5,825.1	5,013.7	4,895.4	5,122.5	5,180.3	5,078.1	5,237.9
Michigan	144.5	131.9	127.3	147.0	146.1	156.0	166.4
Mississippi	157.9	144.2	140.8	139.7	124.1	102.6	97.7
Montana	51.5	52.5	46.6	46.5	51.7	51.3	49.8
New Mexico	957.4	905.3	702.6	823.8	791.8	854.6	962.4
North Dakota	70.5	72.6	55.1	62.3	57.7	51.2	57.6
Oklahoma	1,985.9	1,936.3	1,917.5	2,004.8	2,106.6	2,185.2	2,184.2
Texas	6,185.0	6,052.7	6,151.8	6,126.3	6,286.0	6,241.4	6,351.8
Utah	74.7	83.4	90.0	87.2	101.4	120.1	145.9
W. Virginia	143.7	144.9	135.4	160.0	174.9	177.2	194.3
Wyoming	516.7	416.6	403.3	498.0	509.1	665.7	692.3
Others	462.4	467.3	481.6	457.6	462.1	475.3	462.6
Total	18,229.6	17,198.0	16,790.9	17,348.5	17,841.5	18,029.3	18,468.7
Volume change	1,407	−1,032	−407.1	557.6	493	187.8	439.4
Percent change	8.4	−5.7	−2.4	3.3	2.8	1.1	2.4

*Includes nonhydrocarbon gases.

Source: Energy Information Administration



NATURAL GAS PRICES



NATURAL GAS PRICES	1984	1985	1986	1987	1988	1989	1990
	$/Mcf						
Wellhead price	2.66	2.51	1.94	1.67	1.69	1.69	1.72
Import price	4.08	3.19	2.53	2.17	2.00	2.04	2.03
Industrial sales price	4.22	3.95	3.23	2.94	2.95	2.97	2.92
Residential price	6.12	6.12	5.83	5.54	5.47	5.64	5.77

Source: Energy Information Administration

moved up $4.77/mcf from $1.29/mcf in 1973 to $6.06/mcf in 1984.

The price paid for natural gas by electric utilities moved up 963%, and the residential price for natural gas moved up 369.8% during the 1973–1984 period. These huge price increases led to a great deal of conservation and fuel switching on the part of gas consumers. Faced with an increase in natural gas energy costs of that magnitude, a major effort was made by all consumers to conserve on natural gas consumption.

In response to the falling prices of competing fuels and declining natural gas demand, natural gas prices started to fall in 1985. The price decline accelerated in 1986 and continued into 1987 and 1988. But as in the past, in 1986 the natural gas industry did not react quickly enough to the sharp drop in crude oil prices, and demand and market share were lost. In mid-1986, for the first time on record, the price paid by steam electric utility plants for heavy oil fell below natural gas. The price per million BTU for heavy oil fell below natural gas in April 1986 and remained lower through October 1986. The price per million BTU for heavy oil fell as low as $1.841 in July 1986. The natural gas price in July was $2.161 per million BTU. As a result of this change in price relationships, natural gas lost market share to fuel oil in the utility sector in 1986.

In addition to competition from other fuels, increased gas to gas competition has been putting downward pressure on prices. With excess deliverability, gas producers and distributors were competing with each other for the same customers. This had the affect of lowering gas prices without substantially increasing demand for natural gas.

However, the average U.S. wellhead price for natural gas moved up slightly to an average $1.69/mcf in 1988 and 1989. This modest increase was due to increased demand for natural gas. Demand was up 4.6% in 1988. The price in 1988 and 1989 was down $0.97/mcf, 36.5%, from the peak of $2.66/mcf in 1984. The impact of the price drop is being felt in the consumption of natural gas, which is on the rise. With increased demand, the price of natural gas inched up again in 1990 to $1.72/mcf.

CONSUMPTION. Consumption of natural gas fell from 22.05 tcf in 1973 to 16.84 tcf in 1983, a drop of 23.6%. It rebounded to 17.95 tcf in

1984, an increase of 6.6% from the previous year. It dropped slightly to 17.28 tcf in 1985. It then fell sharply to 16.221 tcf in 1986.

The drop in gas prices and more aggressive marketing has helped boost consumption in the period 1987 through 1990. Consumption in 1987 jumped back up to 17.211 tcf and it continued up in 1988 to 18.030 tcf, in 1988. This trend continued with natural gas consumption moving up to 18.799 tcf in 1989 and 18.803 tcf in 1990. The increase in crude oil prices in 1987 helped boost natural gas demand. The competitive advantage of natural gas in the utility and heavy industry markets increased, and there was a shift to natural gas as the fuel of choice. However crude oil prices fell again in 1988, and natural gas consumption continued to increase. This indicates that natural gas was solidifying a share of the energy market. In 1989 and 1990 low natural gas prices helped to sustain demand levels. Demand moved up in 1990, even though the U.S. economy was sliding into a recession.

Natural gas has held a cost advantage over heating oil in the residential market and a cost advantage over residual fuel oil in the utility and industrial sectors. By 1982 a substantial portion of this cost advantage had eroded. Therefore natural gas found itself facing competition it had not encountered before. In the residential sector, conversions from home heating oil to natural gas slowed. And in the industrial and utilities sectors, natural gas fell victim to the recession and to competition from other fuels. The Fuel Use Act which existed then also contributed to the problem. The regulations gave utilities and heavy industry low priority in the case of a natural gas supply curtailment. Without supply assurances, utilities and industry sought other fuels. The Fuel Use Act also restricted expansion of gas generation facilities.

In addition, utilities and industry moved toward installing multiple fuel capabilities so they would have the flexibility to take advantage of any price differential between fuels. The volume of multifuel capacity increased markedly because of the high cost of energy. This resulted in intense competition for natural gas in many of its historical markets. If energy prices move up again multifuel capability may also become prevalent in future years for residential and commercial heating.

What is encouraging for the industry is that some of the impediments to consumption such as the Fuel Use Act have been removed. Attempts are being made to move the natural gas market toward a more market responsive industry. It is expected that these moves will tend to boost consumption. However, in order to compete, the gas industry has to adjust prices to meet fuel competition. The recent level of natural gas prices has increased

PRODUCTION, IMPORTS

	Total marketed prod.	Imports (Billion cu ft)	Total new supply*	Imports % total supply
1973	22,648	1,033	23,681	4.4
1974	21,601	959	22,560	4.3
1975	20,109	953	21,062	4.5
1976	19,952	964	20,916	4.6
1977	20,025	1,011	21,036	4.8
1978	19,974	966	20,940	4.6
1979	20,471	1,253	21,724	5.8
1980	20,180	985	21,165	4.7
1981	19,956	904	20,860	4.3
1982	18,520	933	19,453	4.8
1983	16,822	920	17,742	5.2
1984	18,230	843	19,073	4.4
1985	17,198	950	18,148	5.2
1986	16,791	750	17,541	4.3
1987	17,349	993	18,342	5.4
1988	17,841	1,294	19,135	6.8
1989	18,029	1,382	19,411	7.1
1990	18,469	1,512	19,981	7.6

*Before losses.

Source: Energy Information Administration

its competitive position and stimulated consumption.

SUPPLY AND PRODUCTION. Marketed production of natural gas in the United States followed demand, falling from 22,648 bcf in 1973 to 16,822 bcf in 1983, down 25.7%. Production moved up in 1984 to 18,230 bcf, an increase of 8.4%. However, production fell again in 1985, down 5.7% to 17,198 bcf. Domestic production continued this downward movement, falling to 16,791 bcf in 1986. This was the lowest level of domestic marketed production since 1965.

With increased demand, production has moved up in the last 4 years, 1987 through 1990. Production increased to 17,349 bcf in 1987, 17,841 bcf in 1988, 18,029 bcf in 1989, and 18,469 bcf in 1990. Production in 1990 was 10% higher than the level in 1986.

When natural gas prices were rising, there was no concern about the availability of natural gas. The higher gas prices stimulated the supply side for natural gas. Exploration and production activity moved up sharply during the drilling boom years 1979–1982. The number of gas wells completed moved up from 3,983 in 1971 to 19,742 in 1981 and 18,363 in 1982. And the number of completions remained relatively high during the 1983–1984 period. Gas well completions dropped to 14,619 in 1983, then moved up to 17,201 in 1984. But gas well drilling has slipped in recent years, falling to 12,875 in 1985, 8,096 in 1986, and 8,114 in 1987. With increased demand, gas well drilling moved up markedly during the last 3 years even though drilling activity was in a slump. Gas well completions moved up to 8,403 in 1988, 9,005 in 1989, and 9,796 in 1990..

Gas well drilling had been depressed due to a combination of low demand and low prices. Low demand had a particularly large impact on the economics of gas well drilling. Because of low demand and a gas surplus, some gas wells had to be shut in. There was no guaranteed market for gas, and this sharply reduced the incentive for drilling. This environment has changed along with the increased consumption of natural gas.

With high production rates and little new development, U.S. natural gas reserves fell between 1973 and 1979. Natural gas reserves fell sharply from 249,950 bcf in 1973 to 194,917 bcf in 1979, down 22%. The reserves–production rate fell from 11.04 years in 1973 to 9.52 years in 1979.

However, with the increased exploration and drilling activity, reserves were sustained and actually increased slightly between 1979 and 1984. However, with the decline in drilling, reserves began to fall again, dropping to 187,211 bcf in 1987. But because of the low level of production, the reserves production ratio was up to 10.79 years.

Reserves fell sharply in 1988 to 168,024 bcf. And the reserves to production ratio dipped to 9.42 years. The sharp drop in production was due to a reclassification of Alaskan reserves. It was no longer felt that a large percentage of the North Slope reserves could be considered proved reserves. Only the reserves that could be used on the North Slope could be considered proved reserves. Natural gas reserves continued to fall to 167,116 bcf in 1989. The reserves to production ratio dipped further to 9 years. At that time it was felt that the drop in reserves could have a significant impact on future deliverability.

In 1990, for the first time since 1981, U.S. natural gas reserves moved up. Reserves increased 1.3% to 169,346 bcf. There was an increase in gas reserves from coalbed methane. And, it was estimated that additional gas could be obtained from the North Slope which caused the Alaskan reserves to be revised upwards.

There has been concern expressed about the impact of natural gas imports on domestic production. Imports have been moving up rapidly in recent years. From 1973 through 1985, annual natural gas imports ranged from 904 bcf to 1,253 bcf. As a percentage of total supply they ranged from 4.1% in 1974 and 1981 to 5.5% in 1979. The average was 4.5% of total supply. Imports fell to 750 bcf in 1986, only 4% of total supply. This was the lowest level of imports since 1969.

But when demand rebounded in 1987, imports jumped up to 993 bcf, 5.2% of supply. Imports continued to move up sharply in 1988 to 1,294 bcf, 6.4% of total supply. In 1989 imports moved up to 1,382 bcf, still 6.4% of supply. The trend continued in 1990 as imports increased to 1,512 bcf, which was 7.1% of supply.

Almost all of the imports are from Canada. As demand has been on the rise in recent years, Canada has been increasing its gas export capacity. In the past, import prices were higher than domestic prices. Therefore there was no great incentive to increase import volumes. Imports filled a small gap between domestic production and consumption and were concentrated in certain regional areas. However Canada has adjusted prices to be more competitive in the U.S. market. And it is investing in capacity to increase exports to the United States, particularly into the growing Northeastern market.

Natural Gas Liquids (NGL) production fell along with natural gas during the years of decline but not at the same rate. Marketed production of natural gas in 1985 was down 24.1% from 1973. However, NGL production in 1985 was 1.609 million bbl/d, down only 7.4% from 1973. Natural gas production fell another 2.4% in 1986 and NGL production fell 3.6%.

When natural gas production started to increase, the relationship wasn't as close. In 1987 natural gas production moved up 3.3%. NGL output was up 2.8%. Natural gas production increased 2.8% in 1988, and NGL production moved up 1.9% to 1.625 million bbl/d. In 1989 natural gas production increased 1.1%, and NGL production fell 4.9% to 1.546 million bbl/d. In 1990 they moved together with natural gas production increasing 2.4% and NGL output moving up 0.8%.

During the 1973–1985 period, the NGL extraction rate was on the rise. The quantity of gas processed fell 32%, but the extraction rate improved substantially. The volume of natural gas liquids recovered per mcf increased from 1.353 gallons in 1973 to an estimated 1.814 gallons in 1983. This is an increase of 34.1% in the liquid extraction level. The level of extraction is tied to the relative value of the liquids versus the value of the natural gas with a higher liquids content. The extraction rate is still higher than in the 1970s, but it has slipped in recent years. It was down to 1.622 gallons per mcf in 1987 and 1.631 gallons per mcf in 1988. It fell sharply in 1989 to 1.519 gallons per mcf. The extraction rate fell again to 1.488 gallons per mcf processed in 1990.

OUTLOOK

For a number of years there has been a great deal of "long run" optimism expressed concerning the future of the U.S. natural gas industry. But at the same time there has been a great deal of short run pessimism because of current conditions in the industry. It is expected that during this forecast period some of the current problems will be resolved and some of the optimism will be realized.

The optimism is based upon the

advantages of natural gas as a fuel in the current market and under current energy industry conditions. Expectations are for increasing consumption of natural gas both in the United States and elsewhere in the world. And it is felt that there is a substantial domestic and international resource base to support that increase in future consumption.

In recent years the natural gas industry has found itself in the role of "swing fuel source" in a very competitive energy market. Structural problems slowed the industry response to rapidly changing competitive conditions. This made it difficult for natural gas to respond to the rapid price changes in the energy industry. The structure of the industry with government price, production, and consumption regulations and with cumbersome contract problems made it less responsive to market changes.

The industry has made changes to position itself for expansion in the future. The contract problems are being resolved and streamlined. The natural gas industry is beginning to become more aggressive in marketing, and this will help it to sustain existing markets and to expand into new markets. The burdensome morass of government regulations is being reduced and/or eliminated. And of prime importance, pricing has become much more flexible and responsive to competing market forces.

During the forecast period, natural gas is expected to face a great deal of competition from competing fuels. The drop in crude oil prices in 1986 substantially increased the competition from distillate and residual fuel oil. Coal already has a price advantage in many areas and is expected to sustain it during the forecast period. It is estimated that more than 40% of the gas market, possibly 6 to 8 tcf, are in the swing market. This is a market with the ability to switch to other energy sources.

In this era of environmental concern, it has a natural advantage as a very clean burning, non-polluting fuel source. And there appears to be a substantial supply of natural gas available. And the domestic reserve base may prove to be much larger than estimated, particularly if an increase in prices stimulates additional exploration. In addition there are substantial additional North American supplies available, particularly from Canada.

Worldwide there are also substantial reserves. However a large portion are located in areas far from major consuming countries. Over time it is expected that the transportation problem will be resolved and costs reduced. This will stimulate international gas trade and increase the worldwide consumption.

Base Scenario — The increase in crude oil capacity worldwide is expected to put downward pressure on prices in the early years of the forecast period. Increases are planned for several major producing/exporting countries including Saudi Arabia. In addition, production from Kuwait and Iraq is expected to return to the market in 1992 and 1993. Production management by OPEC will keep prices from totally collapsing.

The lower energy prices will help to pull the United States out of the recession and to boost economic activity in the world. The increase in economic activity will in turn translate into increased demand for energy, including natural gas.

In addition to the increased demand associated with increased economic activity, there will be increased demand for natural gas related to environmental regulations and concerns. Concern about environmental pollution is beginning to grow worldwide. New technologies are being developed to remove the pollutants from existing fuels. However regulations aimed at cleaning up the environment are

being adopted faster than the new technology. During the interim period, while technology is being developed, large energy users will be looking to a relatively clean burning and non-polluting fuel, natural gas. This will also boost the demand and consumption of natural gas during the forecast period.

Even though crude oil prices are expected to fall in 1992 and 1993, U.S. natural gas prices are projected to move up. Prices will increase due to increased demand to support economic growth and due to increased demand to comply with Clean Air Act regulations. Natural gas demand is projected to move up 3.1% by 1993 to 19.435 tcf. The increase will occur even though natural gas prices will be moving up 22.6% to $1.90/mcf in 1993. However, natural gas prices are extremely depressed in 1991 so the rate of increase is somewhat distorted by the base year.

During the remainder of the forecast period 1994–1996, crude oil prices will be moving up due to increased product demand and a reduction in the excess capacity. With an increase in crude oil prices, natural gas will not be at as great a price disadvantage. However, it is primarily the increase in demand for natural gas during the remainder of the forecast period that will lead to a continuing increase in natural gas prices.

Demand for natural gas is expected to continue to move up, increasing to 20.505 tcf in 1996, up 8.8% from 1991. Natural gas prices are expected to move up steadily also. The average U.S. wellhead price will increase to $2.40/mcf in 1996. During the forecast period 1991–1996, the average wellhead gas price will move up 54.8%. However, as pointed out before, the rate of increase is inflated by the low base price in 1991.

The increase in consumption will be driven mainly by the increase in electric utility demand for natural gas. Electric utility sector demand is projected to move up 23% during the forecast period to 3.476 tcf in 1996. As electric power demand increases along with economic growth, the utility sector will need fuel for additional power generation. Nuclear power is not expected to grow significantly since no new plants are planned for construction. Until new technology is developed, there are Clean Air Act problems with burning large additional quantities of coal. Heavy fuel oil is relatively expensive compared to natural gas. And there are physical capacity limitations on increases from hydroelectric power. The remaining fuel for utilities to use for expanded power generation is natural gas.

Industrial demand for natural gas is also expected to increase, moving up 7.5% to 7.555 tcf in 1996. Industries are also concerned about environmental regulations and are looking to natural gas as an interim solution. Increased demand will also be associated with economic growth.

Both residential and commercial demand are projected to move up 5.6% during the forecast period. Residential demand will increase to 4.78 tcf and commercial demand will increase to 2.845 tcf. In both of these sectors there will be conversions to natural gas. However the increase will be offset by increased efficiency in heating and air conditioning units.

U.S. marketed production will follow demand during the forecast period. U.S. marketed production is expected to move up steadily, but the increase will not be as great as the increase in demand. Imports will continue to capture a growing share of the market. U.S. marketed production will move up 5.7% to 19.24 tcf in 1996.

Imports will move up substantially during the forecast period. Imports, mainly from Canada, are projected to move up 40.1% to 2.2 tcf 1996. There will be increased imports of LNG, but this will remain a small portion of U.S. supply.

One of the keys to growth in natural gas consumption is a competitive price level. Gas prices will remain competitive but will move up faster than oil for a variety of reasons. Demand for natural gas is expected to move up. Natural gas prices in 1991 were abnormally low and therefore the rate of growth appears greater. And the clean burning, non-polluting nature of natural gas will make it the fuel of choice because of environmental considerations rather than purely cost considerations. Natural gas prices are forecast to climb throughout the forecast period. The average U.S. wellhead price is expected to move up 54.8% by 1996 to $2.40/mcf. The residential price will increase 15.5% to $6.70/mcf in 1996. During the forecast period 1992–1996, the rate of increase in natural gas prices will be greater than the rate for crude oil.

Following are some of the key elements in the predictions for the natural gas industry during the forecast period.

Economic activity is expected to stimulate demand for energy and in particular demand for natural gas.

Environmental concerns about the continued consumption of coal and heavy fuel oil will give a boost to natural gas demand during the forecast period and for an extended time to come.

Fuel to generate electric power should be on the rise. However growth of coal consumption for power generation may be slower than projected due to the environmental concerns. And growth in nuclear generation is expected to peak in 1993. Therefore a widening gap may develop for natural gas. Imports are expected to move up during the forecast period. Almost all of the imports will be from Canada. But there also may be small volumes of LNG imports from Algeria and Indonesia. Basic demand in the United States is moving up, and some new markets are opening up in the Northeast. The Canadians are expanding their pipeline system and production capacity to meet this new demand. Additional U.S. pipeline capacity to the expanding markets will be required.

Deliverability surplus is not expected to be a problem. The increase in demand is expected to exceed any increase in deliverability. Additional exploration and drilling activity should increase actual total deliverability in the future. But although drilling activity will increase during the forecast period, it is not expected to be sufficient to create a arge deliverability surplus. It is expected that deliverability will remain somewhat in balance with demand.

If some of the problems associated with government regulations are removed, the industry could come closer to reaching its full potential. The development of the spot market for natural gas and the increase in contract carriage are already making the natural gas industry more flexible and competitive. This will help natural gas retain its market share.

NATURAL GAS

KEYS TO THE FUTURE

1. Oil prices will fall in 1992 and 1993 due to the addition of a substantial volume of crude oil production capacity worldwide. Lower oil and energy prices will help to stimulate economic growth and energy demand. With increased energy demand, the consumption of natural gas will increase.

2. Natural gas demand will continue to move up throughout the forecast period. Demand will move up due to the continued economic growth and concerns for environmental pollution. Natural gas will be a fuel of choice to meet environmental regulations. Much of the growth in natural gas demand will be from the electric utilities sector. Natural gas will fill the gap for power generation while new fuel technologies are developed to meet clean air goals. Nuclear power growth will slow substantially during the forecast period and open up opportunities for natural gas. Demand for natural gas is projected to move up 8.8% by 1996.

3. Marketed production of natural gas in the United States will move up with demand. Although there will be increases in imports, the growth in consumption will also stimulate increased domestic production. U.S. marketed production in 1996 will be up 5.7% to 19.24 tcf.

4. Natural gas prices will move up during the forecast period. Both demand for economic growth and demand to help resolve environmental problems will help boost prices throughout the forecast period. Oil prices will move up through the latter part of the forecast period 1994–1996. This will help keep natural gas prices competitive. The U.S. average wellhead price for natural gas will move up 54.8% to $2.40/mcf in 1996.

5. Imports will increase due to increased demand and an expanding market in the northeastern United States. Imports will move up faster than either demand or domestic production. Imports are projected to move up 40.1% to 2.2 tcf in 1996.

THE OUTLOOK — NATURAL GAS

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
NATURAL GAS VOLUMES									
(billion cubic feet)									
Marketed production	18,469	18,200	18,370	18,550	18,750	18,980	19,240	+1,040	+5.7
Imports	1,512	1,570	1,695	1,820	1,945	2,070	2,200	+630	+40.1
Demand	18,803	18,850	19,125	19,435	19,760	20,110	20,505	+1,655	+8.8
SECTOR NATURAL GAS DEMAND									
(billion cubic feet)									
Residential	4,371	4,525	4,565	4,610	4,665	4,720	4,780	+255	+5.6
Commercial	2,618	2,695	2,720	2,750	2,780	2,810	2,845	+150	+5.6
Industrial	7,241	7,030	7,115	7,215	7,320	7,430	7,555	+525	+7.5
Electrial utilities	2,786	2,825	2,930	3,050	3,180	3,310	3,475	+650	+23.0
Pipeline & plant fuel	1,787	1,775	1,795	1,810	1,815	1,840	1,850	+75	+4.2
Total	**18,803**	**18,850**	**19,125**	**19,435**	**19,760**	**20,110**	**20,505**	**+1,655**	**+8.8**
PRICES									
U.S. wellhead price	1.72	1.55	1.75	1.90	2.10	2.25	2.40	+0.85	+54.8
($ per thousand cubic feet)									
Residential price	5.77	5.80	5.90	6.10	6.30	6.50	6.70	+0.90	+15.5
($ per thousand cubic feet)									

OUTLOOK 2000 — NATURAL GAS

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
NATURAL GAS VOLUMES									
(billion cubic feet)									
Marketed production	18,469	18,980	20,140	+511	+1,160	+1,671	+2.80	+6.1	+9.0
Imports	1,512	2,070	2,580	+558	+510	+1,068	+36.9	+24.6	+70.6
Demand	18,803	20,110	21,760	+1,307	+1,650	+2,957	+7.0	+8.2	+15.7
SECTOR NATURAL GAS DEMAND									
(billion cubic feet)									
Residential	4,371	4,720	4,790	+349	+70	+419	+8.0	+1.5	+9.6
Commercial	2,618	2,810	2,920	+192	+110	+302	+7.3	+3.9	+11.5
Industrial	7,241	7,430	7,720	+189	+290	+479	+2.6	+3.9	+6.6
Electrical utilities	2,786	3,310	4,420	+524	+1,110	+1,634	+18.8	+33.5	+58.7
Pipeline & plant fuel	1,787	1,840	1,910	+53	+70	+123	+3.0	+3.8	+6.9
Total	**18,803**	**20,110**	**21,760**	**+1,307**	**+1,650**	**+2,957**	**+7.0**	**+8.2**	**+15.7**
PRICES									
U.S. wellhead price	1.72	2.25	3.05	+0.53	+0.80	+1.33	+30.8	+35.6	+77.3
($ per thousand cubic feet)									
Residential price	5.77	6.50	7.40	+0.73	+0.90	+1.63	+12.7	+13.8	+28.2
($ per thousand cubic feet)									

OTHER ENERGY SOURCES

It now appears that conditions are very favorable for continuous U.S. and worldwide economic growth. And the grov.th will be fueled by increasing demand for energy of many forms.

Energy costs will remain reasonable for an extended period of time. The favorable outcome of the conflict in the Middle East has led to a period of price stability. It also has led to an expected period of relatively

ELECTRICITY GENERATION AND FUEL CONSUMPTION

	Total electricity generated (Billion kwh)	Fuels consumed: Coal (1,000 st)	% of total	Petroleum (1,000 bbl)	% of total	Natural gas (Bcf)	% of total	Nuclear, hydro & other % of total
1975	1,917.6	405,962	44.5	506,128	15.1	3,157.7	15.6	24.8
1976	2,037.7	448,371	46.4	555,920	15.7	3,080.9	14.4	23.5
1977	2,124.3	477,126	46.4	623,705	16.9	3,191.2	14.4	22.3
1978	2,206.3	481,235	44.2	635,839	16.6	3,188.4	13.8	25.4
1979	2,247.4	527,051	47.8	523,297	13.5	3,490.5	14.7	24.0
1980	2,286.4	569,274	50.8	420,214	10.8	3,681.6	15.1	23.3
1981	2,294.8	596,797	52.4	351,111	9.0	3,640.2	15.1	23.5
1982	2,241.2	593,666	53.2	249,771	6.6	3,225.5	13.6	26.6
1983	2,310.3	625,211	54.5	245,497	6.3	2,910.8	11.9	27.3
1984	2,416.3	664,399	55.5	204,479	5.0	3,111.3	12.3	27.2
1985	2,469.8	693,841	56.8	173,414	4.1	3,044.1	11.8	27.3
1986	2,487.3	685,056	55.7	230,482	5.5	2,602.4	10.0	28.8
1987	2,572.1	717,894	56.9	199,378	4.6	2,844.1	10.6	27.9
1988	2,704.3	758,372	57.0	248,096	5.5	2,635.6	9.3	28.2
1989	2,784.3	766,888	55.8	267,451	5.7	2,787.0	9.6	28.9
1990	2,807.1	771,678	55.5	196,175	4.2	2,786.2	9.4	30.9

Source: Energy Information Administration

low oil and energy prices. Low energy costs would result in additional capital available for other productive activity. With energy at a lower cost level it is highly probable that consumption of energy will increase. As always there will be fuel switching and movement away from the higher cost types of energy.

One of the fundamental requirements for sustaining economic activity or achieving economic growth is energy. Energy is a necessary input for all economic activity. The need for energy to fuel economic activity has not been eliminated. What has changed to a degree is the quantity of energy required and the type of energy consumed.

Energy growth and economic growth moved up at about the same rate for an extended period. All through the growth years of the 1950s and 1960s, energy growth and economic growth moved up at the same rate. During that period energy was inexpensive relative to other costs and therefore was consumed only with concern for increased production. There was little concern for energy conservation. But that relationship between economic growth and energy growth changed markedly when the price of oil and other energy increased rapidly in the 1970s. With the cost of energy moving up rapidly and having a major impact on production costs, a great deal more thought was given to energy conservation and minimizing the cost of energy.

In addition to the changing relationship between economic growth and energy, there has been a marked shift in the relative share of energy coming from major energy sources. In recent years, oil and natural gas have been losing market share to other basic energy sources—coal, nuclear, hydro, geothermal, and others. In general the other forms of energy are lower cost sources of energy and are therefore preferable if there are no operational problems associated with their use.

Oil and natural gas are sill the dominant energy sources and together supply 65% of the U.S. energy needs and 60% of worldwide energy needs. But they do not satisfy all energy needs. Petroleum and natural gas are in fact, to a large extent, the higher cost "swing fuels" satisfying energy needs not met by other fuels. This is particularly true with respect to energy for electrical generation and for heavy industry. Those sectors of the economy look to natural gas and petroleum only when there is insufficient energy available from cheaper fuel sources, such as coal, hydroelectric, and nuclear. This has been particularly true since the 1970s when the price of petroleum sky-

ELECTRIC SECTOR: RELATION TO TOTAL PRODUCT DEMAND

	Total coal consumption	Coal consumed in electric generation	%	Total petroleum consumption	Petroleum consumed in electric generation	%	Total natural gas consumption	Natural gas consumed in electric generation	%
	— (1,000 short tons) —			— (1,000 b/d) —			— (Bcf) —		
1973	562,584	389,212	69.2	17,308	1,535	8.9	22,049	3,660.2	16.6
1979	680,524	527,051	77.4	18,513	1,433	7.7	20,241	3,490.5	17.2
1987	836,941	717,894	85.8	16,665	546	3.3	17,211	2,844.1	16.5
1988	883,664	758,372	85.8	17,283	678	3.9	18,028	2,635.6	14.6
1989	890,559	766,886	86.1	17,325	733	4.2	18,799	2,787.0	14.8
1990	894,556	771,678	86.3	16,988	537	3.2	18,803	2,786.2	14.8

Source: Energy Information Administration

rocketed and natural gas prices soon followed.

Petroleum does have its secure niche as a liquid fuel for transportation, a role that does not appear to be threatened by fuel switching. Most long range forecasts do not see any immediate major economic alternative for petroleum as a transport fuel. But even in this sector of economic activity some alternatives have been introduced. Automobiles and small trucks have been converted to use propane, and there is continuous experimentation with electric cars for short range city transport.

Natural gas is capturing a substantial part of the home heating market. It has a definite advantage as a clean burning, efficient, and relatively low cost fuel. Natural gas also has an established market in the industrial and utility sectors, provided it remains price competitive. Its advantage as a clean burning, non-polluting fuel could translate into increased demand in the future. This is particularly true if environmental concerns about acid rain and clean air remain important political and environmental objectives. Given the current mood, it is almost a certainty that these and other environmental issues will be of primary concern during the forecast period.

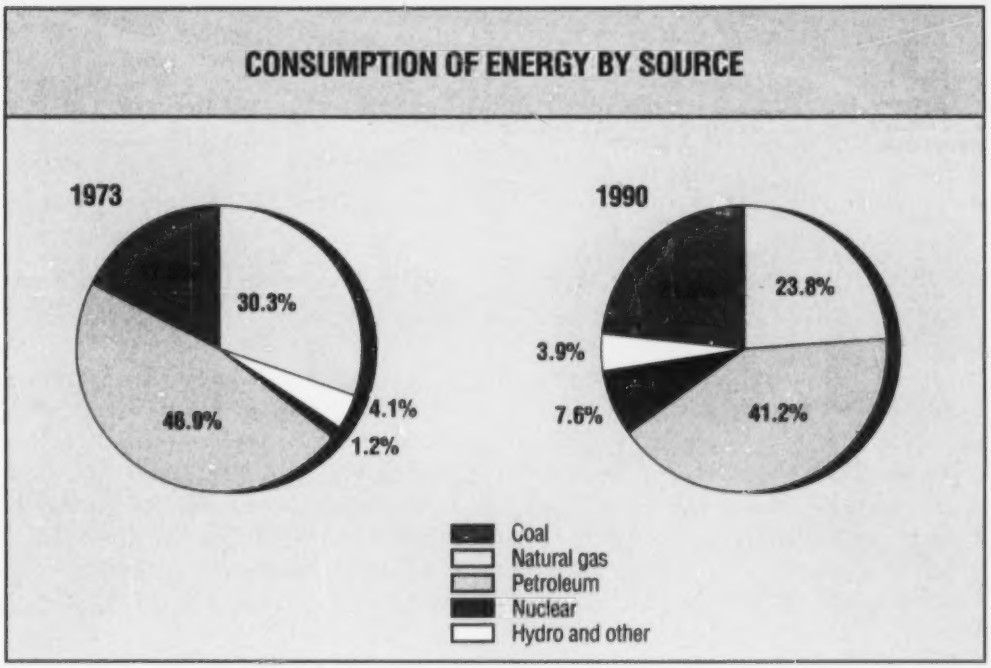
At the low oil prices that occurred in 1986, all of the three major fuel sources, petroleum, natural gas, and coal, were competing in the industrial market. It is likely that the future will see more competition between fuels due to the increased multifuel capacity of major consumers.

Oil prices have been going through a period of sharp cyclical changes influenced by OPEC production decisions ever since 1986. Oil prices recently have been much lower than in the preceding several years. In addition natural gas prices moved down during this period in order to keep natural gas competitive with other fuels.

Lower energy prices tend to slow the conservation effort. And the lower cost of petroleum and natural gas markedly changes the economics of investing in capital equipment for conversion to other fuels. The lower cost of energy lengthens the pay-back period on the increased capital investment required for new capital equipment, and in many cases conversion is uneconomical.

With higher oil costs the economics change. Conversion or switching to other fuels becomes economical again. It also becomes cost effective to enact conservation programs and to invest in more fuel efficient equipment. But these decisions will not be made spontaneously but will be studied carefully to determine the economic benefits. Therefore the length of time that prices remain relatively moderate could determine energy consumption patterns during the forecast period.

What happens with respect to total energy demand and what happens with respect to demand for other forms of energy will have a major impact on the future for crude oil and natural gas.



REVIEW

The energy industry has gone through several major transitions and shifts in direction during the past 20 years. The frequent substantial changes in the cost of energy has been one of the major reasons for the rapidly shifting conditions in the energy industry. Another factor having a major impact on energy requirements is the gradual shift of the economy to a more service oriented, less industrial economy. These two factors have greatly influenced the quantity and type of energy consumed.

Energy prices started to move up in the 1970s following a long period of relatively low-cost energy. The increase was led by petroleum prices which first moved up in 1973–1974 and then rapidly increased from 1979–1981. Natural gas prices followed and also started accelerating upward in the late 1970s and early 1980s. Coal and electric power prices also followed.

All forms of energy rapidly became more expensive during this time period. This huge increase in the cost of basic energy made it very attractive for energy users to find ways to conserve on the level of energy consumption. In addition, when prices for competing forms of energy were out of balance, it became cost effective to switch, if possible, to other lower cost forms of energy. Therefore, it became economically attractive to invest in capital equipment that would reduce energy consumption. And it became cost effective to invest in equipment to establish multifuel capability, so that large fuel users could select the least costly fuel.

Over that period, and continuing until today, the economy was in transition to a more service oriented and automated economy. This newly evolving economy is less ener-

gy intensive than an economy dominated by heavy industry. Accompanying that transition is a shift toward more electrical power consumption in the new service economy. All of these shifts had an impact on the quantity and type of fuel that was consumed.

Conservation led to a drop in energy consumption per unit of economic activity. Energy consumption per unit of GNP had been falling continuously since 1970. But the increase in prices accelerated the reduction. Energy consumed per unit of GNP has fallen 29.5% between 1970 and 1990 and is still falling. With low energy costs and a sharp increase in energy consumption the improvement in efficiency slowed briefly from 1986–1988. But it appears to have resumed again. Low energy prices tend to reduce energy consumption efficiency.

The total amount of energy consumed peaked in 1979 at 78,898 trillion BTU. It fell 10.6% to 70,524 trillion BTU in 1983. It was then oscillating up and down for a few years. It moved up to 74,101 trillion BTU in 1984, down to 73,945 trillion BTU in 1985, and then back up to 74,237 trillion BTU in 1986. Energy consumption has been climbing since 1985. It moved up to 76,845 trillion BTU in 1987, 80,195 trillion BTU in 1988, 81,345 trillion BTU in 1989, and 81,367 trillion BTU in 1990. Energy consumption has moved up 10% during the five years 1985–1990. However this was also a period of extended economic growth.

Between 1979 and 1990, GNP increased 30.2%, while the energy consumed to fuel the increased economic activity moved up only 3%. This is in sharp contrast to the earlier era 1950–1970. During that span, GNP moved up 100.2% and energy consumption increased 97.5%. At that time there was a one to one relationship between economic growth and energy growth. This changed markedly with higher energy costs.

COAL PRODUCTION

	Production	Consumption	Imports	Exports
	(1,000 short tons)			
1975	654,641	562,640	940	66,309
1976	684,913	603,790	1,203	60,021
1977	697,205	625,291	1,647	54,312
1978	670,164	625,225	2,953	40,714
1979	781,134	680,524	2,059	66,042
1980	829,700	702,729	1,194	91,742
1981	823,775	732,628	1,043	112,541
1982	838,111	706,910	742	106,277
1983	782,091	736,671	1,271	77,772
1984	895,921	791,291	1,286	81,483
1985	883,638	818,049	1,952	92,680
1986	890,315	804,312	2,212	85,518
1987	918,762	836,941	1,747	79,607
1988	950,265	883,664	2,134	95,023
1989	980,729	890,559	2,851	100,815
1990	1,029,035	894,556	2,699	105,804
% chg. 90/75	+57.2	+59.0	+187.1	+59.6

Source: Energy Information Administration

There was a substantial shift in energy market shares for the various fuels between the years of peak energy consumption, 1979 and 1985. Petroleum's share of the energy market fell from 47.1% in 1979 to 41.8% in 1985. The share from natural gas fell from 26.2% to 24.1%. The lost market share was taken by coal, nuclear, hydroelectric, and geothermal energy. Coal energy moved up from 19.1% to 23.6% of the market in 1985. Hydroelectric and geothermal moved up from 4.1% to 4.9%, and nuclear power increased from 3.5% to 5.6% of the energy market.

Due to the sharp drop in crude oil prices in 1986, there was a temporary shift in the trend of market shares. Petroleum's share moved up to 43.4%, coal fell to 23.2%, natural gas fell to 22.5%, nuclear moved up to 6.1%, and hydro and others slipped to 4.8%.

Higher crude oil prices changed the competitive mix again in 1987. In 1987 petroleum dropped slightly to 42.8%. Natural gas moved up to 23%, coal moved up to 23.5%, nuclear moved up again to 6.4%, and hydro fell to 4.3%. Although petroleum prices fell again in 1988, market share slipped to 42.7%. Natural gas moved up to 23.1% of the market. Coal stayed at 23.5%, but nuclear

NUCLEAR POWER PLANT OPERATIONS

	Number of reactors	Electricity generated (Million net kwh)	% of total electricity generated	Net summer capability (Million net kw)	Capacity utilized (%)
1975	54	172,505	9.0	37,161	56.0
1976	61	191,104	9.4	43,657	54.9
1977	65	250,883	11.8	46,202	63.4
1978	70	276,403	12.5	50,709	64.7
1979	68	255,155	11.4	49,630	58.5
1980	70	251,116	11.0	51,668	56.4
1981	74	272,674	11.9	55,914	58.4
1982	77	282,773	12.6	59,927	56.7
1983	80	293,677	12.7	63,009	54.4
1984	86	327,634	13.6	69,652	56.3
1985	95	383,691	15.5	79,397	58.0
1986	100	414,038	16.6	85,241	56.9
1987	107	455,270	17.7	93,583	57.4
1988	108	526,973	19.5	94,695	63.5
1989	110	529,355	19.0	98,161	62.2
1990	111	576,862	20.6	99,588	66.1
% chg 90/75	+105.6	+234.4	—	+168.0	—

Source: Energy Information Administration

jumped to 7.1% of total energy. Due to poor weather conditions, hydroelectric and other energy fell to only 3.6%.

In 1989 the energy mix shifted again. Petroleum slipped again to 42.1% of the market while natural gas moved up again to 23.8%. Hydroelectric, geothermal, and other miscellaneous energy managed to recapture a small share of the market moving up to 3.8%. As a result, coal slipped to 23.3%. Nuclear fell to 7%, the first market share decline for nuclear. Some shutdowns for maintenance slowed the growth in nuclear energy in 1989.

In 1990 the petroleum share dipped again to 41.2%, while natural gas stayed at 23.8%. The coal share moved up to 23.5%. Nuclear jumped up to 7.6% of the market, and hydroelectric and others moved up slightly to 3.9%.

ELECTRICAL ENERGY. The growth in consumption of electrical power has been one of the most consistent and long-term trends in the energy industry. In addition, the portion of total energy used for generating electrical power has been steadily increasing.

In 1947, just after World War II, only 12.9% of total U.S. energy consumption went for generation of electrical power. As the economy grew and changed this increased substantially. By 1961 it had climbed to 18.8%, and by 1971 it was up to 25.2% and still climbing. It reached 33.5% in 1981 and 36.4% in 1990. Over one-third of all energy consumed is now used for electric power generation.

This upward trend to a higher percentage of energy for electrical power will continue for the foreseeable future. The economy is shifting to more service and information oriented activity, and industry is shifting toward more automation. Both of these movements call for energy in the form of electricity.

Net electricity generation at electric utilities has moved up in every year but one since 1973. Net electricity generated in 1973 was 1,860.7 billion kilowatt hours. This has increased 50.9% to 2,807.1 billion kilowatt hours in 1990. This translates to an average annual growth rate of 2.5% over 17 years. During the same period energy consumption moved up only 9.5%.

Demand for electricity has gone up in all sectors of the economy. Growth has been greatest in the commercial sector, reflecting the shift to a service economy. Commercial consumption has increased 93.8% from 1973–1990. Residential demand has increased 59.1%, and industrial demand has moved up 36.8%.

Electrical energy is produced using all of the basic forms of energy: petroleum, natural gas, coal, hydro, nuclear, geothermal, and others. Coal has been and continues to be the primary fuel source for electrical utilities. In 1973 coal accounted for 43.6% of the fuel for electric power generation. This moved up to 54.6% in 1985. Coal lost a portion of its utility market share in 1986, due to the extremely low oil prices, and fell slightly to 54.2%. With the increase in oil prices in 1987, coal moved back up to 55% of the energy for electric utilities. It moved up again to 55.3% in 1988,

55.8% in 1989, and slipped to 55.5% in 1990.

The level of total coal consumption is mostly dependent upon electric utility demand. Therefore coal consumption has been rising rather steadily during this period of fluctuating energy demand. Coal consumption moved up from 562.6 million short tons in 1973 to 818 million in 1985, an increase of 45.4%. Consumption declined slightly in 1986, falling to 804.3 million short tons, down 1.7%. It rebounded in 1987, increasing 4.1% to 836.9 million short tons. With strong electricity demand it increased 5.6% in 1988 to 883.6 million short tons. It moved up marginally in 1989, 0.8%, to 890.6 million short tons.

Coal consumption levels vary with economic activity, but increased consumption by electric utilities has continued to push up demand. Coal consumed by electric utilities increased 78.3%, from 389.2 million short tons in 1973 to 693.8 million short tons in 1985. The percentage of total coal consumed in electric power generation increased from 69.2% in 1973 to 84.8% in 1985. During this period, coal consumed by utilities moved up 305 million short tons, while total coal consumption moved up only 255 million short tons. The long-run growth in coal consumption is obviously dependent upon the growth in electrical power generation.

However coal does face some potential competition, even in electric power generation. When oil prices dropped to extremely low levels during mid-1986, coal lost some of its utility market to petroleum. As a result, in 1986, coal consumption by electric utilities fell 8.8 million short tons to 685.1 million short tons. Total coal consumption fell 13.7 million short tons. Coal consumption by industrial coke plants also fell in 1986, dropping 5.1 million short tons.

Oil prices moved back up in 1987, reducing some of the competitive pressure. Coal consumption by electric utilities increased 4.8% to 717.9 million short tons. This was an increase of 32.8 million short tons. Total coal consumption moved up 32.6 million short tons. Even though oil prices fell again in 1988, coal consumption moved up on the strength of electric utility demand. Coal consumed by electric utilities increased 5.6% in 1988, increasing 40.5 million short tons to 758.4 million short tons. It increased only 1.1% in 1989 to 766.9 million short tons. In 1990 coal consumption by electric utilities moved up 0.6% to 771.7 million short tons. Electric power from hydro facilities was down in 1988 but moved up in 1989. This accounted for the pattern in utility coal consumption in those two years. In 1990 coal replaced a large share of petroleum as a fuel for electric utilities. Electric power produced by petroleum fell 26%.

Nuclear power's share of total electrical power generation has also been rising steadily. The nuclear power share of total energy used for electrical generation increased from 4.6% in 1973 to 19.5% in 1988 and 19% in 1989. Nuclear power growth slowed in 1989 due to maintenance requirements. In 1990 nuclear generation bounced back and accounted for 20.6% of electrical generation.

The number of operable nuclear reactors increased from 39 at year end 1973 to 111 at the end of 1990. The peak capacity defined as "net summer capacity of operable reactors" moved up from 22.615 million net kilowatts in 1973 to 99.588 million net kilowatts at year end 1990. Electricity generated from nuclear facilities increased from 83.5 billion net kilowatt-hours in 1973 to 576.9 billion net kilowatt-hours in 1990, an increase of 591% in electrical power generated.

Although the power generated by nuclear facilities has steadily increased along with the capacity, the utilization rate of the reactors has fluctuated. The percentage of capacity utilized has fluctuated from a low of

47.9% in 1974 to a high of 66.1% in 1990.

After the Three Mile Island incident, the utilization rate decreased. Concerns for safety increased the amount of time the reactors were shut down for maintenance and safety checks. The rate fell to 54.4% in 1983. It was 56.3% in 1984, 58% in 1985, and 56.9% in 1986. It moved up to 57.4% in 1987, 63.5% in 1988, and 62.3% in 1989. The utilization rate was down in 1989 as a number of units were undergoing maintenance. It is felt that there is considerable room for improvement in the utilization rate. Additional power could be generated without new facilities if the utilization rate was increased. This would be a major factor in the future growth of nuclear power. Only a few new units are to be completed in the future.

Hydroelectric power supplied 10% of energy for electric power generation in 1990, this was up from 9.5% of energy for electric power generation in 1989 and only 9.1% in 1988. Hydroelectric power energy output dropped to 2,639 trillion BTU in 1988, the lowest level in years. It has moved up the last two years to 2,942 trillion BTU in 1990. The hydro energy output depends upon weather conditions such as rainfall and snowfall in certain regional areas. The rainfall and snow melt were very low in 1987 and 1988. Hydropower hit a peak in 1983 at 3,899 trillion BTU. This was 15.5% of the energy for electric power that year.

The natural gas share of energy consumed for electrical power generation fell from 18.9% in 1973 to 10.1% in 1986. It moved up slightly to 10.7% as it recaptured market share from petroleum in 1987. But it fell again in 1988 dropping to 9.5%, moved up to 9.6% in 1989, and fell to 9.4% in 1990. Total natural gas energy consumed for electric power generation was 3,866 trillion BTU in 1983. It was down to 2,607 trillion BTU in 1988 and back up slightly to 2,909 trillion BTU in 1990.

The volume of gas consumed by electric utilities fell 29%, from 3,660 bcf in 1973 to 2,602 bcf in 1986. This decline accounted for 17.5% of the overall drop in natural gas consumption from 1973–1986. There was a loss of 442 bcf in 1986 as natural gas lost market share in the utility sector to low cost heavy fuel oil. The volume moved up to 2,844 bcf in 1987. Gas prices were more competitive with crude oil prices, and gas regained a portion of the utility market. However consumption in this area fell again in 1988 to 2,636 bcf. In 1989 low heavy fuel oil prices enabled oil to displace some natural gas, as it had in 1986. Natural gas consumption for electric power generation increased to 2,787 bcf in 1989. It stayed at this level in 1990 at 2,786 bcf.

The share of total natural gas consumed by electric utilities was 16.6% in 1973. It moved up to 18.8% in 1981. At that time, there were concerns about natural gas shortages developing in other sectors of the economy, and government restrictions were placed on natural gas use by utilities. The share fell to 17.3% in 1983 and down to a low 16.0% in 1986. In 1986 competitive pressure from extremely low cost heavy oil reduced the volume of natural gas consumed by electric utilities. It jumped back up to 17.1% in 1987 when crude oil prices moved higher, and gas regained its competitive advantage. The share of gas used for power generation fell sharply in 1988 to 14.6%. Power plants switched to lower cost heavy fuel oil again in 1988. In 1989 and 1990 natural gas consumed by power plants increased only marginally to 14.7% and 14.8%.

The largest drop in natural gas consumption was in the industrial sector. Industrial natural gas consumption fell 35.8% from 8,689 bcf in 1973 to 5,579 bcf in 1986. This was a drop of 3,110 bcf. It accounted for 53.3% of the decline in natural gas consumption between 1973 and 1986. Conservation,

ELECTRICITY SALES

	Residential	Commercial	Industrial (Million kwh)	Other	Total
1975	588,140	403,049	687,680	68,222	1,747,091
1976	606,452	425,094	754,069	69,631	1,855,246
1977	645,239	446,514	786,037	70,571	1,948,361
1978	674,466	461,163	809,078	73,215	2,017,922
1979	682,819	473,307	841,903	73,070	2,071,099
1980	717,495	488,155	815,067	73,732	2,094,449
1981	722,265	514,338	825,743	84,756	2,147,103
1982	729,520	526,397	744,949	85,575	2,086,441
1983	750,948	543,788	775,999	80,219	2,150,955
1984	777,654	578,281	840,588	81,849	2,278,372
1985	790,977	608,968	824,523	85,075	2,309,543
1986	817,663	641,469	808,292	83,409	2,350,835
1987	849,613	673,707	845,266	86,854	2,455,440
1988	892,125	697,711	895,751	82,362	2,567,949
1989	903,979	725,229	926,376	91,066	2,646,651
1990	921,739	752,763	938,362	93,649	2,706,512
% chg 90/75	+56.7	+86.8	+36.5	+37.3	+54.9

Source: Energy Information Administration

fuel switching, and an economic shift away from heavy industry all contributed to the decline.

With somewhat of a resurgence of industrial activity, consumption of natural gas in the industrial sector moved up in 1987 increasing 316 bcf, 5.7%. Lower prices for natural gas, higher prices for heavy fuel oil, and more aggressive gas marketing accounted for the increase. The upward swing in gas consumption in industrial activity continued strong in 1988 and 1989. In 1988 it moved up another 7.2%, 430 bcf, to 6,383 bcf. In 1989 natural gas consumption in the industrial sector moved up 459 bcf, an increase of another 7.2% to 6,842 bcf. This trend continued in 1990, and industrial natural consumption of natural gas moved up another 6.2% to 7,241 bcf.

The petroleum energy share of energy used for electric power generation fell from 17.7% in 1973 to 4.1% in 1985. Substantially lower heavy fuel oil prices in 1986 stimulated electric utility consumption of petroleum. The petroleum share moved up to 5.5% in 1986 as the energy input from petroleum increased 33.2%. In 1986 the price of heavy residual fuel oil fell to a level that was competitive with natural gas and even coal in electrical power generation. The electrical utilities with multi-fuel capability shifted to residual fuel consumption to take advantage of the lower cost.

With higher fuel oil prices in 1987, the share of electric power from petroleum fell to 4.6%. But lower prices in 1988 boosted the share back up to 5.5%. Even with slightly higher prices for fuel oil, the share increased to 5.8% in 1989. But the jump in oil prices in 1990 reversed this trend, and the petroleum share fell to 4.2%.

The volume of oil consumed in electric power generation fell 69% from 560 million barrels in 1973 to 173 million barrels in 1985. It rebounded to 230 million barrels in 1986 due to lower oil prices. Consumption slipped back in 1987 to 199 million barrels as oil prices rebounded. But prices plummeted again in 1988, and oil consumption by electric utilities jumped up to 248 million barrels. It moved up again in 1989 to 267 million barrels. The high oil prices in 1990 made petroleum less competitive, and the consumption fell to 196.2 million barrels.

The drop in petroleum used for power generation is the major reason for the decline in heavy residual fuel oil consumption. The share of total petroleum consumption used for electrical power generation fell from 8.9% in 1973 to 3.0% in 1985. It moved up to 3.9% in 1986 but slipped to 3.3% in 1987. It bounced

back to 3.9% in 1988 as utility consumption of petroleum increased sharply. The share used for electric power generation moved up to 4.2% in 1989 but dropped to 3.2% in 1990.

As the economy continues to shift toward services, information, and automation, electrical power demand is expected to continue to increase. The energy sources that provide the fuel for power generation will also continue to grow during the forecast period.

OUTLOOK

It now appears that worldwide crude oil production capacity will be increasing substantially over the next few years and throughout the forecast period. Several major producing/exporting countries have announced plans to boost production capacity. In addition, output from Iraq and Kuwait will be resuming and entering the world market.

Demand for petroleum products will also be moving up during the forecast period. But demand will not move up as fast as production capacity. The excess capacity that develops will put downward pressure on prices. This is expected to result in only a modest increase in crude oil prices during the forecast.

The worldwide and U.S. economies are expected to grow at a modest pace during the forecast period. Economic growth and relatively low oil and energy prices should help boost energy consumption throughout the forecast period.

Offsetting this growth will be continued efforts aimed at improving energy conservation. The industrial economies of the world and the U.S. economy are expected to continue the shift toward industries that are less energy intensive—with movement toward the service and information industries and away from energy intensive heavy manufacturing industries. The result will be a continued improvement in energy efficiency during the forecast period. The energy consumed per real GNP dollar is expected to decline another 5% to 6% by 1996.

Consumption of all forms of basic energy are expected to increase by the end of the forecast period. The relative amounts of each type of energy consumed will be influenced a great deal by the increase in electrical power demand. The shift toward a more service oriented and automated economy will boost demand for electrical power. Electrical power consumption is projected to increase faster than total energy.

The growth in electrical power generation will be fueled mainly by growth in hydropower, coal, and nuclear energy during the earlier years of the forecast period.

Nuclear power generation is projected to move up at a slower pace than in the past years. It is projected to peak in 1993 due to the safety concerns that have prevented the construction of additional capacity. No new nuclear plants are being planned. Therefore when existing construction is completed, growth in nuclear power will slow. Nuclear plant capacity will not be increased after 1994, but there could be increased energy from an improvement in the utilization rate of nuclear capacity. Increased capacity utilization in some facilities will boost power generation from nuclear facilities marginally during the latter part of the forecast period.

The extent of growth in nuclear power generation beyond the forecast period is in doubt. Long range growth of nuclear power has become more of a political and environmental issue than an economic decision. Concerns about the safety of nuclear facilities has almost halted the growth in nuclear capacity beyond the forecast period. With lead times of 10 years or more for plan-

ning and construction of new facilities, increased capacity can not be expected in the foreseeable future. Any additional output can only be obtained if plant efficiency improves and the utilization rate of existing facilities moves up.

With the increase in electrical power demand, coal consumption will also increase during the forecast period. The one issue that may cloud the longer range outlook for the increase in coal consumption is concern about the environment. If environmental concerns about acid rain and clean air end up adding a lot to the cost of consuming coal, it could lose some of its competitive price advantage over petroleum and natural gas. In that case the growth of coal consumption would be slowed. This forecast assumes that coal will be able to maintain its competitive advantage. However this is an area of major concern and could greatly influence future trends.

Hydroelectric power generation and other sources of energy are expected to move up substantially from the depressed levels of 1988 and 1989. Hydropower is dependent upon weather conditions. A return to more normal, wetter weather and a build up of the reservoirs will boost hydro output. Hydropower is projected to move up close to existing capacity during the forecast period.

Lower oil and natural gas prices could make these fuels more competitive in the electrical power generation market. When oil prices are elevated, utilities will shift to other energy sources. Oil and natural gas are not expected to make a great deal of headway until the growth in nuclear generation slows and coal consumption becomes a major environmental issue.

Later in the forecast period, an energy gap may develop that will have to be filled by increased natural gas or petroleum consumption. Nuclear energy growth is expected to start to slow in 1993. Growth from hydropower and other energy sources also will slow later in the forecast period. Energy from coal also may also be constrained due to environmental concerns. Therefore energy from these fuel sources will not be sufficient to meet the total energy requirements for electric power generation.

A recent survey of utility capacity construction plans confirms these expectations. Of 80 power units in the planning stages, 62 are being planned to burn natural gas and/or oil. Only 7 are slated to burn coal in baseload steam plants.

During most of the forecast period, the growth in demand for petroleum energy is expected mainly in economic sectors where it has an advantage as a liquid transport fuel, and in industrial sectors such as petrochemicals where it is an important feedstock.

Natural gas will be a major swing fuel during the forecast period 1992–1996. The level of demand for natural gas will depend upon the rate of economic growth and growth in energy demand.

Base Scenario — Increased crude oil production capacity will put downward pressure on oil prices during the forecast period. Oil prices will move up but at a slow rate. The low oil prices will help to keep all energy costs reasonable. Continued economic growth and low energy prices will boost energy demand during the forecast period.

The lower oil prices in 1992 and 1993 will help boost economic growth and energy demand. Energy consumption is projected to move up 3.6% to 82.495 quadrillion BTU in 1993. Consumption of all energy sources including natural gas is expected to move up during the early years of the forecast period. Energy from natural gas will move up 3.1% to 20.035 quads in 1993, even though natural gas

prices will be moving up faster than oil prices. Natural gas will be the fuel of choice for environmental reasons.

Oil and energy prices will move up during the latter part of the forecast period but at a very slow rate. Relatively low energy prices over the remainder of the forecast period will help boost economic growth and energy consumption. At the end of the forecast period, 1996, energy consumption will be up 9%. Electrical power generation will be up 9.4% in 1996. The slowdown in growth of electrical power generation from hydroelectric facilities and the peaking of nuclear power output in 1993 will result in increased demand for natural gas later in the forecast period.

It should be noted that beyond the forecast period, providing adequate electrical power to meet the growing demand for electricity may become a serious problem. The major sources of energy for electrical power generation are coal and nuclear power and to a lesser extent hydropower. The first two of these energy sources are under attack from groups concerned about nuclear power dangers and potential environmental pollution. And hydropower has limited capacity. What could develop in the future is a surge in demand for natural gas and possibly even petroleum for electric power generation.

OTHER ENERGY SOURCES

KEYS TO THE FUTURE

1. Economic activity will continue to grow throughout the forecast period. Oil prices are expected to fall early in the period due to excess crude capacity. Lower oil prices will keep energy costs down and boost the rate of economic growth.

2. Energy consumption will move up with the growth in economic activity. Total U.S. energy consumption will increase throughout the forecast period. Low oil prices will help keep the cost of energy from escalating rapidly, and this will boost energy consumption.

3. The shift toward less energy intensive industries will continue. The U.S. economy will become more service and information oriented. This will result in a growing demand for electrical power which is projected to be up 9.4% by 1996.

4. Nuclear power generation capacity will peak in 1994. The growth of generation of electrical energy from nuclear power will slow early in the forecast period, since no new capacity will be added. After 1994 any growth will be due to an improvement in the rate of capacity utilization.

5. Hydropower energy will rebound and move back toward capacity. This will supply some of the growth in energy required for additional electric power generation. Energy from other renewable sources will begin to grow.

6. Coal consumption will increase 8.9% during the forecast period. The increase will be due to the growth in electrical power demand. Coal consumption could run into some environmental problems during the forecast period.

7. Natural gas energy consumption will move up during the forecast period. The peaking of power output from nuclear facilities and environmental concerns about coal should result in more demand for natural gas. Annual natural gas energy consumption will be up 8.8% in 1996 at the end of the forecast period.

THE OUTLOOK — OTHER ENERGY SOURCES

	1990	1991	1992	1993	1994	1995	1996	Change 1991 to 1996	% change 1991 to 1996
ENERGY DEMAND — U.S.									
(trillion BTU)									
Petroleum	33,553	32,960	33,505	34,130	34,715	35,300	35,890	+2,930	+8.9
Natural gas	19,386	19,430	19,720	20,035	20,370	20,735	21,140	+1,710	+8.8
Coal	19,094	19,180	19,515	19,875	20,220	20,565	20,925	+1,745	+9.1
Nuclear	6,186	6,160	6,265	6,340	6,380	6,395	6,425	+265	+4.3
Hydro and other	3,148	3,350	3,490	3,645	3,795	3,950	4,000	+650	+19.4
Total energy demand	**81,367**	**81,080**	**82,495**	**84,025**	**85,480**	**86,945**	**88,380**	**+7,300**	**+9.0**
COAL CONSUMPTION	895	900	915	930	945	965	980	+80	+8.9
(million short tons)									
ELECTRICITY GENERATION	2,807	2,830	2,890	2,950	3,000	3,050	3,095	+265	+9.4
(billion kilowatt hours)									
NUCLEAR CAPACITY	100	100	101	102	103	103	103	+ 3	+3.0
(million kilowatts)									
NUCLEAR GENERATION	577	575	585	590	595	595	600	+25	+4.3
(billion kilowatt hours)									

OUTLOOK 2000 — OTHER ENERGY SOURCES

				Change			% change		
	1990	1995	2000	1990 to 1995	1995 to 2000	1990 to 2000	1990 to 1995	1995 to 2000	1990 to 2000
ENERGY DEMAND—U.S.									
(trillion BTU)									
Petroleum	33,553	35,300	37,170	+1,747	+1,870	+3,617	+5.2	+5.3	+10.8
Natural gas	19,386	20,735	22,430	+1,349	+1,695	+3,044	+7.0	+8.2	+15.7
Coal	19,094	20,565	22,050	+1,471	+1,485	+2,956	+7.7	+7.2	+15.5
Nuclear	6,186	6,395	6,550	+209	+155	+364	+3.4	+2.4	+5.9
Hydro and other	3,148	3,950	4,360	+802	+410	+1,212	+25.5	+10.4	+38.5
Total energy demand	**81,367**	**86,945**	**92,560**	**+5,578**	**+5,615**	**+11,193**	**+6.9**	**+6.5**	**+13.8**
COAL CONSUMPTION	895	965	1,035	+70	+70	+140	+7.8	+7.3	+15.6
(million short tons)									
ELECTRICITY GENERATION	2,807	3,050	3,335	+243	+285	+528	+8.7	+9.3	+18.8
(billion kilowatt hours)									
NUCLEAR CAPACITY	100	103	105	+3	+2	+5	+3.0	+1.9	+5.0
(million kilowatts)									
NUCLEAR GENERATION	577	595	610	+18	+15	+33	+3.1	+2.5	+5.7
(billion kilowatt hours)									

OPEC

PEC appears to be alive and well and have greater influence on world oil markets than it has had in several years. But OPEC's ability to control current world oil markets is a direct result of the outcome of the recent conflict in the Middle East. The conflict has resulted in the temporary reduction and almost total elimination of the excess capacity in OPEC. It has given OPEC leaders the opportunity to set production

quotas that come close to creating a balance between supply and demand and at a price that is close to the OPEC price objective.

However the above conditions are expected only to last for a short period of time. And the market philosophy of several of the OPEC member countries was also changed by the outcome of that conflict in the Middle East. As OPEC capacity begins to increase, the ability of OPEC to survive will again be questioned.

The ability of OPEC to survive has been repeatedly questioned since its inception 30 years ago. But OPEC has shown a great deal of resiliency since its inception and particularly during the past 10 years. OPEC has survived numerous differences in member country objectives and now has even survived two wars between members.

Last year Iraq invaded and attempted to annex Kuwait. This followed on the heels of the long Iran-Iraq War, also between two OPEC countries. OPEC managed to stay intact through the Iran-Iraq war, and it appears that it has survived the Iraq-Kuwait conflict also.

During the latest conflict, several OPEC members besides Kuwait chose to align with the forces opposing Iraq. The need for security took precedent over ethnic or religious ties. Saudi Arabia and the United Arab Emirates in particular felt it necessary to embrace placing outside forces in the region to thwart the possible aggression by Iraq. And other OPEC members were asked to support the U.N. resolutions requiring an embargo on all exports and imports by Iraq.

Several of the OPEC members did take sides in the war between Iran and Iraq, but most of the assistance or aid was in the form of loans or financial assistance. That war was considered a dispute between two long standing enemies. And forces outside of the region did not get involved in a major way. There were many differences in this recent conflict, and it was felt that it might be more damaging to the fabric that has held OPEC together.

The conflict has forced many of the members of OPEC to closely analyze there membership in OPEC and to question the value of continuing the membership. However, as of this date none of the members have chosen to leave the organization.

But even prior to the conflict, OPEC was splitting into groups with differing interests. A few of the OPEC countries have huge crude oil reserves that would last for many years at current rates of production. It is generally in the best interests of these countries to keep oil price growth moderate and to try to stimulate consumption. It is not in their interest for oil prices to escalate to a level that would instead stimulate conservation and investment in alternative fuels.

The other OPEC countries with smaller reserves generally wish to maximize their current revenues from oil exports. They would prefer to see higher oil prices immediately. Their reserves will not last very long, and they prefer to have current revenue for investment in diversification away from oil.

OPEC has had many problems within the organization with respect to determining a level of production and prices that will satisfy all of the 13 member countries. The internal struggles have led to constantly changing policies and actions by OPEC. And this has kept the worldwide oil and gas industry in a state of turmoil for the past 10–15 years.

It is obvious that the economic interests of these two groups do not coincide. Therefore there may be a split at some time over these differences. However these countries have experienced some success with influencing the oil market via a cartel. And the major oil exporting countries may band together within some new group dedicated to controlling the worldwide oil market.

It is uncertain as to whether OPEC will

have the same type of influence over the oil market during the forecast period 1991–1996 as they have had during the past 15 years. Prior to the invasion it was felt that OPEC's influence was once again on the rise. Worldwide demand for oil products was on the rise. Most of the increase in demand was being supplied by the OPEC countries. And the surplus production capacity that was putting downward pressure on prices was diminishing. This would then put OPEC in a position where they would have more control over crude markets and prices. In particular they would be able to set prices much higher by controlling production volumes.

This would give them influence over other elements in the energy industry. The price of oil has an impact and connection to the price of other competing forms of energy. So OPEC's decisions influence the level of activity in the oil and gas industry and in other energy industries as well.

OPEC DURING THE FORECAST PERIOD. During the recent conflict several OPEC countries, and particularly Saudi Arabia, increased production capacity to make up for the lost production from Iraq and Kuwait. In addition, a number of these and other OPEC countries have announced plans to boost production capacity in the near future.

There has been some minor volume of production in Kuwait, and the volume is expected to slowly increase throughout 1992 and the remainder of the forecast period. It is also expected that the embargo on exports from Iraq will be relaxed, and production in Iraq will also move up during the forecast period. It is expected that production from Iraq and Kuwait will reach levels comparable to the levels prior to the war, during the early years of the forecast period.

Worldwide demand for petroleum is expected to move up during the forecast period, increasing 9.6%, 6.2 million bbl/d, by 1996 to 70.475 million bbl/d. During the same period world oil production outside of OPEC is expected to fall, declining 520,000 bbl/d. The net result is that the call for OPEC oil will be moving up 7.1 million bbl/d during the fore-

OPEC GAS PRODUCTION

1989

Country	Gross	Marketed	Reinjected	Flared	Other losses
	(Billion cu ft)				
Algeria	4,225	1,709	2,106	216	194
Ecuador	25	3	2	20	0
Gabon	77	3	11	61	2
Indonesia	1,942	1,425	318	162	37
Iran	1,540	784	636	53	67
Iraq	406	215	0	172	18
Kuwait	392	288	4	39	61
Libya	487	212	141	118	16
Nigeria	844	166	64	614	0
Qatar	238	215	0	0	23
Saudi Arabia	1,632	1,052	88	138	353
United Arab Emirates	1,035	776	124	40	95
Venezuela	1,370	690	456	127	97
Total OPEC	**14,213**	**7,539**	**3,948**	**1,781**	**985**
% of Total OPEC	**100.0**	**53.0**	**27.8**	**12.4**	**6.8**
Total World	**86,783**	**71,685**	**7,712**	**3,454**	**3,933**
% of Total World	**100.0**	**82.6**	**8.9**	**4.0**	**4.5**

Source: Cedigaz

OPEC TOTAL LIQUIDS PRODUCTION (CRUDE OIL, CONDENSATE, NGL)

Country	1979	1982	1985	1988	1989	1990
	(000 b/d)					
Algeria	1,255	1,045	1,095	1,090	1,205	1,275
Ecuador	215	200	275	305	295	280
Gabon	205	155	155	175	215	250
Indonesia	1,590	1,415	1,335	1,325	1,415	1,520
Iran	3,175	2,410	2,215	2,265	2,845	3,125
Iraq	3,475	1,010	1,440	2,600	2,825	2,005
Kuwait	2,270	705	920	1,340	1,640	1,065
Libya	2,090	1,135	1,105	1,055	1,160	1,350
(Neutral Zone)	570	315	340	320	370	275
Nigeria	2,300	1,285	1,475	1,365	1,635	1,810
Qatar	510	340	340	360	410	455
Saudi Arabia	9,555	6,695	3,565	5,255	5,280	6,700
United Arab Emirates	1,835	1,250	1,350	1,775	2,035	2,300
Venezuela	2,425	1,965	1,730	1,860	2,010	2,365
Total OPEC	**31,470**	**19,925**	**17,340**	**21,090**	**23,340**	**24,775**
Total OECD & LDCs*	**51,275**	**42,185**	**42,580**	**46,560**	**48,230**	**49,975**
Total World	**65,780**	**57,160**	**57,705**	**62,540**	**63,895**	**64,875**
OPEC SHARE:						
% of OECD & LDCs	**61.4**	**47.2**	**40.7**	**45.3**	**48.4**	**49.6**
% Total World	**47.8**	**34.9**	**30.0**	**33.7**	**36.5**	**38.2**

*Organization for Economic Cooperation and Development; and lesser developed countries.

Source: British Petroleum

OPEC RESERVES
CRUDE OIL

Country	1979	1982	1985	Jan. 1 1988 (Million bbl)	1989	1990	1991
Saudi Arabia	165,700	164,600	169,000	166,980	169,970	254,959	257,504
Iraq	32,100	29,700	44,500	100,000	100,000	100,000	100,000
United Arab Emirates	31,316	32,176	32,490	98,105	98,105	98,105	98,100
Iran	59,000	57,000	48,500	92,850	92,850	92,860	92,850
Kuwait	66,200	64,480	90,000	91,920	91,920	94,525	94,525
Venezuela	18,000	20,300	25,845	56,300	58,084	58,504	59,040
Libya	24,300	22,600	21,100	21,000	22,000	22,800	22,800
Nigeria	18,200	16,500	16,650	15,980	16,000	16,000	17,100
Algeria	6,300	8,080	9,000	8,500	8,400	9,200	9,200
Indonesia	10,200	9,800	8,650	8,400	8,250	8,200	11,050
(Neutral Zone)	6,480	6,500	5,420	5,210	5,210	5,200	5,000
Qatar	4,000	3,434	3,350	3,150	3,150	4,500	4,500
Ecuador	1,170	850	1,400	1,615	1,350	1,514	1,420
Gabon	1,970	480	510	645	720	733	730
Total OPEC	**444,936**	**436,500**	**476,415**	**670,655**	**676,009**	**767,100**	**773,819**
Non-OPEC Countries	**196,672**	**234,209**	**222,252**	**216,693**	**231,434**	**234,472**	**225,294**
Total World	**641,608**	**670,709**	**698,667**	**887,348**	**907,443**	**1,001,572**	**999,113**
OPEC SHARE: % World	**69.3**	**65.1**	**68.2**	**75.6**	**74.5**	**76.6**	**77.5**

Source: Oil & Gas Journal

cast period. The expected need for additional oil during the forecast period will have to be met by production from OPEC. In 1991 OPEC supplied 38.6% of the world oil. This will move up to 44.8% in 1996 and 48.5% in the year 2000.

OPEC capacity is expected to move up much faster than demand during the first few years of the forecast period. As a result of this there will be an increase in OPEC excess capacity. The excess capacity will tend to put downward pressure on crude oil prices during the forecast period. However the lower price level will stimulate demand for crude oil and therefore demand for OPEC oil. This is consistent with the objectives of the OPEC countries with large reserves. It is highly likely that these countries will be dictating policy during the forecast period.

This section takes a close look at OPEC and the many changes that have taken place in the industry. It also looks closely at the reasons why OPEC has had considerable influence over the oil market. And it also points out why OPEC has had problems with controlling the market.

OPEC HISTORY

THE OPEC ORGANIZATION. OPEC was formed in 1960 with the original participating countries being Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. It has since grown to include 13 countries. The 13 member countries and the year they joined OPEC is listed below:

1960
Iran
Saudi Arabia
Iraq
Venezuela
Kuwait

1961
Qatar

1962
Indonesia
Libya

1967
Algeria
Abu Dhabi (now part of UAE)

1971
Nigeria

1973
Ecuador
Gabon

1974
United Arab Emirates:
Abu Dhabi
Ras al Khaymah
Dubai
Sharjah

OPEC RESERVES NATURAL GAS

Country	Jan. 1 1978	1983	1989	1990	1991	Gross production 1990 (Bcf)	Production/ Reserves (Years)
			(Billion cu ft)				
Saudi Arabia	85,000	117,000	145,848	181,347	180,355	1,741	104
Iraq	28,000	28,800	95,000	95,000	95,000	321	296
United Arab Emirates	21,500	28,580	201,515	200,800	200,400	1,053	190
Iran	500,000	482,600	494,400	500,000	600,350	1,642	366
Kuwait	31,500	29,900	42,500	48,600	48,600	250	194
Venezuela	41,000	54,079	102,243	100,846	105,688	985	107
Libya	25,700	21,500	25,700	25,500	43,000	572	75
Nigeria	43,000	32,400	85,000	87,400	87,400	978	89
Algeria	125,000	111,250	104,200	114,000	114,700	4,471	26
Indonesia	24,000	29,600	83,590	87,015	91,450	2,073	44
(Neutral Zone)	5,000	8,380	12,300	12,000	10,000	—	—
Qatar	40,000	62,000	156,700	163,000	163,200	276	591
Ecuador	5,000	4,100	4,020	3,990	3,950	25	158
Gabon	2,450	485	600	560	490	88	6
Total OPEC	**977,150**	**1,010,674**	**1,553,816**	**1,620,158**	**1,744,583**	**14,475**	**121**
Non-OPEC Countries	**1,541,287**	**2,020,365**	**2,401,725**	**2,368,961**	**2,463,732**	**73,811**	**33**
Total World	**2,518,437**	**3,031,039**	**3,955,341**	**3,989,119**	**4,208,315**	**88,286**	**48**
OPEC SHARE: % World	**38.8**	**33.3**	**39.3**	**40.6**	**41.5**		

Source: Oil & Gas Journal, Cedigaz

From time to time OPEC has made overtures to other petroleum exporting countries to determine if they had an interest in joining with the cartel. But the OPEC cartel has remained at a group of 13 since 1974. Some of the other major exporting countries are Mexico, USSR, Norway, Angola, Egypt, and the United Kingdom.

PRODUCTION. From its inception, OPEC production moved up steadily and rapidly. OPEC production statistics were first tabulated in 1961, and output was 9.364 million bbl/d. At the start, the OPEC countries accounted for 41.8% of total world production and 50.1% of non-communist production. With the addition of new countries and increased demand for oil, output moved up rapidly to 30.989 million bbl/d in 1973. In that year OPEC output was 55.5% of world production and 67.5% of non-communist world production. This was also at the time that OPEC first pushed up the price of crude oil.

In 1975 OPEC output dropped to 27.155 million bbl/d, due to the demand response of higher oil prices and an economic recession in some of the industrial countries. With renewed worldwide economic growth and demand for oil, OPEC production rebounded to 31.298 million bbl/d in 1977. This was just before the large price hikes that took place in the years 1979–1981. OPEC output stayed at close to this level for the next few years and was at 30.928 million bbl/d in 1979.

The sharp increase in prices that took place had a substantial impact on product demand. Conservation, fuel switching, and economic stagnation all worked together to reduce demand for petroleum products. The drop in demand and increased competition from non-OPEC production combined to have a major impact on demand for OPEC oil.

Production fell steadily and reached a recent low of 16.039 million bbl/d in 1985. This was a drop of 48.1%, 14.889 million bbl/d, from 1979. In 1985 OPEC production represented only 29.9% of total world output and 42.4% of non-communist production. The

OPEC-PRODUCTION CAPACITY

Country	Capacity	Production Av. 1990 (000 b/d)	Excess capacity	% utilization
Algeria	900	794	106	88.2
Ecuador	300	286	14	95.3
Gabon	250	274	−24	109.6
Indonesia	1,300	1,289	11	99.2
Iran	3,600	3,136	464	87.1
Iraq	3,500	2,080	1,420	59.4
Kuwait	2,200	1,079	1,121	49.0
Libya	1,600	1,374	226	85.9
(Neutral Zone)	600	312	288	52.0
Nigeria	1,850	1,804	46	97.5
Qatar	600	393	207	65.5
Saudi Arabia	7,500	6,302	1,198	84.0
United Arab Emirates	2,300	2,117	183	92.0
Venezuela	2,500	2,107	393	84.3
Total OPEC	**29,000**	**23,347**	**5,653**	**80.5**

*Capacity prior to the Iraq-Kuwait conflict.

aggressive pricing policy adopted by OPEC had made it the swing producer or crude supplier of last resort for the consuming countries.

Consumers invested in conservation equipment or adopted conservation measures to reduce energy and oil consumption. Where possible, consumers also switched to other cheaper fuel sources. This substantially reduced the demand for crude oil, and most of the reduction was in demand for OPEC oil.

In addition, the high prices stimulated exploration and production elsewhere in the world. This enabled some countries to replace costly OPEC imports. It also resulted in the development of competing export countries. These countries could profitably undercut OPEC prices and capture OPEC market share. As a result, consuming importing countries only called upon expensive OPEC crude oil to fill the gap between the required imports to fuel economic growth and imports from cheaper non-OPEC sources.

When OPEC production fell, it left behind a substantial volume of excess crude oil production capacity in a number of the OPEC countries. The excess capacity created an element of competition between OPEC member countries. Coupled with competition from increasing non-OPEC production, this put downward pressure on prices.

Prices slid gradually after hitting a peak in 1981 and 1982. The slow price slide continued through 1983, 1984, and 1985. OPEC adopted a quota system in 1983 in an attempt to prop up prices and stop the slide. Due mainly to the production cuts by Saudi Arabia, this restraint on production prevented a rapid deterioration of prices during this period.

However, in 1985 Saudi Arabia grew tired of unilaterally propping up prices. Because the other OPEC countries did not cooperate, the Saudis were required to make massive production cuts to prevent a decline in prices. Saudi Arabia unilaterally decided on a new policy and set out to secure an acceptable portion of the market. They adopted a netback pricing system and locked in several crude customers to ensure adequate exports. Later that year all of OPEC met and adopted a similar scheme to pursue market share. At the start of 1986, OPEC attempted to try to regain some of their lost market share through price competition. The result was an extended period of overproduction and a collapse in prices. OPEC production did move up to 18.074 million bbl/d in 1986. But there was a substantial loss of revenue since the price decline was far greater than the increase in production.

OPEC abandoned the market share objective in late 1986 and returned to production quotas as a means of trying to stabilize the market at an acceptable price. OPEC adopted new production quotas in September 1986, and prices began to firm at a slightly higher level. But prices firmed at a level about 30% lower than 1985 and 50% below the peak years.

But as a result of even this increase in prices, demand for OPEC oil fell again and OPEC production dropped to 18.584 million bbl/d in 1987. In 1988 competition developed again among the OPEC countries with excess capacity. That year a number of the countries exceeded the quotas and pushed excess crude

onto the market. As a result, prices fell sharply again in 1988. OPEC output moved up to an estimated 19.657. But again, for OPEC as a whole, substantial revenue was sacrificed for market share. However, individual countries may have increased production sufficiently to gain in revenue. The countries that were hurt the most were those without a large level of excess capacity and that could not boost production.

In 1989, increased demand for oil helped boost OPEC production. Prices remained relatively firm throughout the year, and total output still moved up averaging 22.010 million bbl/d. This was the highest average annual production rate for OPEC since 1981.

Producing over quota continued to be an OPEC problem during the first half of 1990. During the first half of the year, the excess output weakened prices substantially. Refiners added to their stock levels, and OPEC production for the first half increased to 23.944 million bbl/d. The second half of 1990 was dominated by the Iraq invasion of Kuwait and the subsequent OPEC adjustment to this lost production.

Kuwait and Iraq together had total average production of 4.909 million bbl/d during the first half of 1990. Initially it did not appear that the remaining OPEC countries had sufficient capacity to meet the expected demand for OPEC oil in the latter months of 1990. And this expectation of a possible shortage in the fourth quarter led to a sharp rise in oil prices.

In the second half of 1990 production by the other OPEC countries moved up much faster than anticipated as some countries expanded capacity beyond expectations. This was particularly true for Saudi Arabia. Prior to the invasion, the production capacity of Saudi Arabia was estimated at 7 million bbl/d. Prior to the invasion, they were producing at 5.4 million bbl/d. They boosted production to 8.3 million bbl/d by the end of the year.

As a result of the jump in production by the OPEC countries not involved in the conflict, OPEC production for the year averaged 23.347 million bbl/d. This was up 6.1% from 1989 even though two major producers were not contributing for five months of the year.

Exports from Iraq and Kuwait have not been resumed as of the first half of 1991. The other OPEC countries have sustained their higher output level in 1991. Production has averaged about 22.85 million bbl/d.

OPEC PETROLEUM PRODUCT PRODUCTION — CONSUMPTION — EXPORT 1989

	Refinery production	Domestic consumption	Exports
	(1,000 b/d)		
Algeria	472.1	168.1	393.3
Ecuador	101.6	93.3	23.0
Gabon	14.7	7.4	1.6
Indonesia	640.4	547.9	230.8
Iran	653.6	778.5	38.0
Iraq	421.7	303.4	145.0
Kuwait	783.6	72.3	690.0
Libya	274.0	107.7	127.5
(Neutral Zone)	—	—	—
Nigeria	182.8	257.7	30.0
Qatar	49.3	13.4	75.0
Saudi Arabia	1,474.0	717.7	1,072.6
United Arab Emirates	180.7	114.2	155.0
Venezuela	1,010.1	367.5	617.7
Total OPEC	**6,258.6**	**3,549.1**	**3,599.5**

Source: OPEC Statistical Bulletin

OPEC-CRUDE EXPORTS

Country	1979	1983	1989	Volume change 1989/79	% change 1989/79
	(000 b/d)				
Algeria	960.4	260.4	280.5	−679.9	−70.8
Ecuador	122.6	159.4	174.6	52.0	42.4
Gabon	164.8	136.4	173.3	8.5	5.2
Indonesia	1,077.7	858.3	675.7	−402.0	−37.3
Iran	2,407.0	1,718.7	2,025.0	−382.0	−15.9
Iraq	3,247.0	702.0	2,260.0	−987.0	−30.4
Kuwait	2,083.1	544.4	850.0	−1,233.1	−59.2
Libya	1,966.0	937.4	872.0	−1,094.0	−55.6
(Neutral Zone)	—	—	—	—	—
Nigeria	2,210.1	935.2	1,525.9	−684.2	−31.0
Qatar	494.9	279.5	320.0	−174.9	−35.3
Saudi Arabia	8,817.7	3,920.8	3,335.5	−5,482.2	−62.2
United Arab Emirates	1,805.3	1,077.3	1,650.0	−155.3	−8.6
Venezuela	1,408.3	976.7	986.3	−422.0	−30.0
Total OPEC	**26,764.9**	**12,506.5**	**15,128.8**	**−11,636.1**	**−43.5**

Source: OPEC Statistical Bulletin

PRICES — DEMAND — OPEC PRODUCTION

	1975	1979	1983	1987	1989	1990
Crude oil price — Saudi Light ($/bbl)	12.38	24.00	29.00	17.53	16.18	20.81
OECD & LDCs* product demand (000 b/d)	44,575	51,280	45,250	48,510	51,450	52,225
OPEC production (000 b/d)	27,535	31,470	18,435	19,115	23,340	24,775

*Organization for Economic Cooperation and Development; and lesser developed countries

OPEC PRODUCTION/RESERVES RATIO

Country	Reserves Jan. 1, 1991 (Million bbl)	Production Av. 1990 (000 b/d)	Production First half 1991 (000 b/d)	Production/ Reserves (Years)
Saudi Arabia	257,504	6,302	7,963	112-89
Iraq	100,000	2,080	227	132–1,207
United Arab Emirates	98,100	2,117	2,439	127–110
Kuwait	94,525	1,079	30	240–8,632
Iran	92,850	3,136	3,323	81–77
Venezuela	59,040	2,107	2,333	77–69
Libya	22,800	1,374	1,500	45–42
Nigeria	17,100	1,804	1,875	26–25
Indonesia	11,050	1,289	1,456	23–21
Algeria	9,200	794	797	32–32
Neutral Zone	5,000	312	27	44–507
Qatar	4,500	393	380	31–32
Ecuador	1,420	286	287	14–14
Gabon	730	274	290	7–7
Total OPEC	**773,819**	**23,347**	**22,927**	**91–92**
United States	**26,177**	**7,613**	**7,437**	**9.4–9.6**
All Non-OPEC Countries	**225,294**	**36,280**	**36,854**	**17.0–16.7**
Total World	**999,113**	**59,627**	**59,781**	**45.9–45.8**

*Production shared by Kuwait and Saudi Arabia.
Source: Oil & Gas Journal

OPEC CAPACITY. The major reason why OPEC had such difficulty with controlling world prices in past years was the massive excess crude oil production capacity in the member countries.

The capacity is in place because it was developed to satisfy growing world demand for crude oil in the 1970s. Worldwide demand for petroleum was on a steady upward trend throughout the 1950s, 1960s, and 1970s. In general, the growth in worldwide economic activity was being fueled by petroleum—low cost petroleum. The international oil companies controlled most of the world crude oil import/export trade. The huge oil reserves they found, mostly in the OPEC countries, enabled them to increase output at a pace to satisfy the increase in world demand. They increased output capacity in line with their projections of growth in demand. They generally operated at a sustainable capacity level of 90–95% of installed developed capacity. This left a small excess capacity for contingencies and for maintenance downtime.

When the OPEC countries finally took control of most of their own production, the total OPEC installed capacity was over 30 million bbl/d and climbing. The sharp escalation in prices that took place in the 1970s and into the early 1980s brought about a reduction in demand for petroleum. As a result the gap between available capacity and production grew rapidly. This new excess capacity was readily available developed capacity that could be utilized without resorting to costly investment.

The worldwide excess capacity grew to 10–15 million bbl/d during the 1983–1986 period, with the vast majority of the excess in OPEC countries. And in 1989 the excess capacity was still estimated at close to 10 million bbl/d. This represents an excess capacity of over 20% of free world demand for crude oil.

Since the period when OPEC production was over 30 million bbl/d, some of the capacity has been eliminated due to the Iran-Iraq War and due to long periods of inactivity. However, it is felt that a portion of this can be brought back on stream with some investment. And the huge reserves in some of the OPEC countries could easily be exploited if a major exploration effort was launched. Therefore additional capacity might be readily available within a relatively short time. This was proven in part during the Kuwait-Iraq War when several OPEC countries, and particularly Saudi Arabia, boosted capacity and production rapidly.

In the past, this overhanging excess capacity made it easy for individual OPEC countries to increase output if they saw an

opportunity to increase their market share. This resulted in periodic "cheating" on quotas and competition between OPEC countries. This in turn helped maintain continuous downward pressure on prices. The downward pressure could be expected to remain until increasing demand eliminated a sufficient portion of the excess capacity.

The Iraq invasion of Kuwait accomplished this by eliminating the combined production capacity of these two countries. Iraq's capacity was estimated at 3.5 million bbl/d and Kuwait's at 2.2 million bbl/d, for a combined total of 5.7 million bbl/d. Elimination of this capacity went a long way toward eliminating the OPEC and worldwide excess capacity.

OPEC capacity was estimated by the CIA at 28.04 million bbl/d prior to the Iraq invasion of Kuwait. Currently, excluding Iraq and Kuwait, OPEC capacity is estimated by the CIA at 23.44 million bbl/d. OPEC is currently producing very close to this capacity.

It is estimated that OPEC capacity will move up substantially during the forecast period. It is projected that OPEC capacity will move up to around 28.5 million bbl/d in 1992 when production from Iraq and Kuwait is resumed in large volumes. OPEC capacity is expected to move up steadily and reach 33.8 million bbl/d by 1996.

Early in the forecast period the additional capacity will increase the level of excess capacity and put downward pressure on prices. World excess capacity will move up to 8.6 million bbl/d in 1992 and 9.5 million bbl/d in 1993. As demand moves up this will drop slightly to 8.5 million bbl/d in 1996. It is expected to remain fairly high and still be 8.1 million bbl/d in the year 2000.

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1989	Change 1989-1982	% change 1989/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	474.5	3.3	0.7
Ecuador	94.5	94.5	135.1	40.6	43.0
Gabon	44.0	44.0	20.0	-24.0	-54.5
Indonesia	473.4	473.4	751.3	277.9	58.7
Iran	1,320.0	670.0	766.0	96.0	14.3
Iraq	305.5	215.5	550.0	334.5	155.2
Kuwait	594.0	594.0	670.0	76.0	12.8
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	400.5	166.5	71.2
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	645.0	765.0	1,425.0	660.0	86.3
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,167.0	-156.1	-11.8
Total OPEC	**5,767.5**	**5,136.2**	**6,926.4**	**1,790.2**	**34.9**

Source: OPEC Statistical Bulletin

OPEC QUOTAS/WORLD OIL PRICES. In 1983 OPEC recognized that the only way they could prevent a rapid slide in prices was to restrict production. They recognized that by balancing world supply and demand it would be possible to slow and possibly stop the decline in prices.

World export prices had peaked in 1981 at about $35.50/bbl. OPEC prices were $34.80/bbl and non-OPEC prices $38.50/bbl. When demand started to slide, non-OPEC export producers undercut OPEC prices to retain market share. With this intense competition in the market, world export posted prices fell to $33/bbl in January 1983. The OPEC price was $33.50/bbl and the non-OPEC price $31.70/bbl.

OPEC adopted their first set of quotas in March 1983 at 17.5 million bbl/d. Even with the OPEC production quotas, prices continued to slide. Therefore in a renewed attempt to balance the market, OPEC lowered the quota to 16 million bbl/d in November 1984. Adoption of this lower production level did manage to support prices throughout 1984 and 1985.

But a disproportionate share of the cut in OPEC production was being borne by Saudi Arabia. They had adopted or accepted the role of swing producer within OPEC. They cut their production to help OPEC stay within the quota and prevent a fall in crude prices. By 1985 Saudi production had fallen to an average of 3.175 million bbl/d. This was down 6.633 million bbl/d, 67.6% from 9.808 million bbl/d

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports	Product exports (1,000 b/d)	Total exports	Value of exports ($ million)	Average value ($/bbl)
1980	22,864.1	2,008.6	24,872.7	284,491	31.25
1981	18,568.8	1,979.3	20,548.1	263,336	35.11
1982	14,296.1	2,225.7	16,521.8	202,791	33.63
1983	12,506.5	2,023.1	14,529.6	156,944	29.59
1984	12,043.9	2,281.3	14,325.2	143,569	27.38
1985	10,926.4	2,368.2	13,294.6	127,180	26.21
1986	12,939.8	2,642.0	15,581.8	76,739	13.49
1987	12,060.4	3,017.2	15,077.6	92,601	16.83
1988	13,367.0	3,395.3	16,762.3	85,933	14.01
1989	13,128.8	3,599.5	18,728.3	116,646	17.06
Average	14,470.2	2,554.0	17,024.2	155,023	24.95

Source: OPEC Statistical Bulletin

in 1981. Total OPEC production had fallen only 6.502 million bbl/d, 28.8%. With the Saudi's willing to play the swing producer role, many of the other OPEC members could sustain their production and not have to sacrifice output to support prices.

In the summer of 1985, Saudi production fell below 2 million bbl/d, and they realized that supporting the OPEC quota unilaterally could be disastrous. At this point they abandoned the swing producer role and adopted a "net-back pricing" scheme to recapture market share. This introduced price competition among OPEC members. Other OPEC countries followed. In December that year OPEC adopted a market share goal and abandoned the goal of supporting a price level. This placed an excessive volume of crude oil on the market. As a result, when winter petroleum demand subsided in early 1986, prices collapsed.

The average export price of OPEC crude fell below $10/bbl by August 1986. In response to the price collapse, in September, OPEC adopted an emergency quota of 16.7 million bbl/d. This helped boost prices to over $13/bbl in September 1986 and up to over $17/bbl by January 1987.

Member countries seemed to learn something from the 1986 experience with the market. OPEC producers stayed close to their quota in 1987, and prices remained above $17/bbl for the year. But some difficulties developed. Iraq had managed to overcome the impact of the war on production and exports, and their crude production was beginning to move up rapidly. They refused to be part of the adopted OPEC quota system. In addition, the UAE had internal problems satisfying the output demands of both Abu Dhabi and Dubai, and they also began producing above quota.

With this excess crude available in the market, after winter demand peaked in early 1988, prices started to slide again. Saudi Arabia adamantly refused to re-adopt the role of swing producer and instead boosted their own production. By October 1988, the prices of some OPEC export crudes had again fallen below $10/bbl. Increased winter demand helped boost prices a bit toward the end of the year. However OPEC met and adopted a new quota for the first part of 1989 in an attempt to boost prices more.

They set a quota at 18.5 million bbl/d. Some production discipline and increased demand for oil helped boost prices in 1989. In order to satisfy some member countries and in response to increased demand, OPEC raised the quota to 19.5 million bbl/d starting July 1989 and to 20.5 million bbl/d starting October 1989. Prices remained relatively firm, and OPEC boosted the quota even further to 22.086 million bbl/d starting January 1990.

During the first half of 1990, OPEC overproduction led to some price weakness. A substantial portion of the additional production was from the UAE which disagreed with the dictated quota. To bring the quota more in line with reality and to satisfy the objections of the UAE, OPEC adopted an adjusted quota of 22.491 million bbl/d to go into affect August 1, 1990. Even though prices were weak, OPEC felt that production discipline at the new quota level and increased winter demand would help boost prices.

Iraq invaded Kuwait before the new quota could take affect. The invasion created a much different market. Before the conflict it appeared obvious that the key to sustaining an acceptable price level was OPEC adherence to a quota that came close to balancing supply and demand. And it was felt that the problem for OPEC was finding a quota and allocation of production method that would satisfy all of its members.

During the conflict OPEC abandoned concern with the quota, and OPEC member countries scrambled to increase output and prevent a worldwide shortage. In April 1991 OPEC adopted a quota of 22.3 million bbl/d excluding output from Iraq and Kuwait. This quota has proven to be very close to a supply demand balance for the market. This quota is also very close to OPEC capacity, and therefore there is little possibility of massive overproduction. This has led to very stable world crude oil prices during most of 1991.

OPEC PRODUCTION QUOTAS

(1,000 b/d)

Country	1984* quota	1984 production	1988 quota	1988 production	1989* quota	1989 production	1990 quota	1990 production
Algeria	663	608	667	641	771	714	827	794
Ecuador	183	258	221	305	254	279	273	286
Gabon	137	150	159	175	184	211	197	274
Indonesia	1,189	1,423	1,190	1,138	1,374	1,235	1,374	1,289
Iran	2,300	2,174	2,369	2,240	2,926	2,947	3,140	3,136
Iraq	1,200	1,210	1,540	2,688	2,926	2,897	3,140	2,080
Kuwait	900	945	996	1,335	1,149	1,593	1,500	1,079
Libya	990	1,091	996	1,025	1,149	1,130	1,233	1,374
Neutral Zone	†	439	†	313	†	397	†	312
Nigeria	1,300	1,414	1,301	1,390	1,501	1,672	1,611	1,804
Qatar	280	396	299	346	346	387	371	393
Saudi Arabia	4,353	4,464	4,343	4,946	5,014	4,995	5,360	6,302
United Arab Emirates	950	1,159	948	1,474	1,094	1,866	1,500	2,117
Venezuela	1,555	1,711	1,571	1,649	1,812	1,725	1,945	2,107
Total	**16,000**	**17,442**	**16,600**	**19,665**	**20,500**	**22,048**	**22,491**	**23,347**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates

OPEC RESERVES AND FUTURE PRODUCTION. Looking at OPEC member country reserves and their reserves to production ratios, it is apparent that OPEC is split into two or three distinct groups.

Ranked by reserves, the top six OPEC countries have 699 billion barrels of proven reserves. These six countries have 91.1% of OPEC reserves, 83.6% of non-communist reserves and 69.7% of total world reserves. Looking at their reserves to production ratios. these individual countries all have close to or over 100 years of reserves. This is at the 1988–1989 rate of production.

The remaining seven OPEC countries have reserves equivalent to 10 to 55 years of current production. Libya is caught in the middle with about 55 years. Nigeria, Algeria,and Qatar have 25–35 years, and the remainder have 20 years or less.

It is obvious that these groups have different short- and long-run objectives. The "big six" producing countries want a higher price for their crude oil, but they don't want to stifle the long-run growth in world demand for petroleum. Their crude oil would have little value if conservation fuel switching and investment in alternative energy and energy efficiency leaves that oil in the ground. These countries are trying to find a production level that will provide sufficient current revenues but will still stimulate demand.

The other group can not expect to sustain production at present levels for an extended period. They therefore are more interested in immediate revenue.

With the production capacity and reserves, it would appear that the "OPEC Big Six" will control OPEC policy. Under present economic conditions it appears that the price they are looking for during the forecast period is in the range of $18–25/bbl. Obtaining that price level and sustaining it has been a dilemma facing OPEC over the last several years. This year they have managed to realize a price for the OPEC basket of crudes at around $18/bbl for a sustained period. However this year is a special situation with a temporary reduction in capacity.

It is obvious from the reserves data that if oil is to be a major energy source for economic growth in the future, then OPEC will be the major supplier. The OPEC group of countries has 76.5% of world oil reserves. However to take advantage of this key position in the worldwide economic structure, they have to find some way to stabilize the political conditions in the Middle East. They also have to find a way to allocate and control production of member countries to balance supply and demand at the target price level. If they do, they will be in an ideal position in the oil market for years to come.

OTHER FORECASTS

In this section other recent forecasts of the U.S. and worldwide energy, oil, and gas industries will be reviewed. Developing an outlook to be used for planning, operating, and investment decisions can be a complex and difficult task. It is often quite rewarding to review a collection of other views, opinions, and forecasts. This can often be a worthwhile and profitable exercise. It reveals other interpretations and projec-

tions of current industry activities and events.

Several groups have made long-range forecasts of the U.S. and worldwide energy and oil industry. These long-range forecasts and the trends they project indicate the underlying economic forces working in the industry. They generally present expectations for the industry absent of political upheavals like the recent situation in the Middle East. Reviewing a variety of outlooks will provide some additional expert opinions about the future of the oil industry.

The following sections are a summary of the highlights from several of these forecasts.

ENERGY INFORMATION ADMINISTRATION — DEPARTMENT OF ENERGY

The U.S. Energy Information Administration (EIA), a section of the U. S. Department of Energy, recently published reports containing long-range outlooks for the U.S. and the worldwide energy, oil, and gas industries.

One EIA publication projecting events in the U.S. industry was the *Annual Outlook for Oil and Gas, 1991,* published in June 1991. The highlights of this report are reviewed here.

The EIA also published an outlook for the worldwide oil and gas industry, *International Energy Outlook 1991: A Post War Review of Energy Markets.* That report was published in June 1991 also, and the highlights are presented in this chapter.

U.S. OUTLOOK. The EIA presented four separate scenarios. The scenarios were based upon three separate price projections: Low World Oil Price, Reference Case or Middle Price Case, and High World Oil Price Case. In addition there is a High Economic Growth Case. The High Economic Growth Case used the same price projections as the Low World Oil Price Case but with an assumption of a higher rate of economic growth. With regard to the outlook scenarios presented, the EIA report states, "In view of the uncertainty that exists concerning future world oil prices, economic growth, conservation efforts, and environmental and other regulations, the forecasts in the report should be interpreted as likely outcomes given specific assumptions, historical trends, and recent events."

As stated, the EIA presents three possible price path cases. Under all three cases prices are expected to move up over the long-range outlook.

With regard to the price projections, the EIA states in the Annual Energy Outlook, "It should be recognized that either political or market influences (or both) could push prices outside this range at any time, at least temporarily. Given the general range, however, market trends from now into the late 1990s would favor continued growth in world oil demand and increased reliance on supplies from the Organization of Petroleum Exporting Countries (OPEC). With no clear reason why these general market trends should change, growth in oil consumption and in OPEC's market share would continue through 2010."

In the Reference Case, the world price of oil (in constant 1990 dollars) moves from $18.81/bbl in 1989 and $21.81/bbl in 1990 to $24.00/bbl in 1995, $25.70/bbl in 2000, and $34.20/bbl in 2010. The average price in 1990 was inflated due to the effects of the conflict in the Middle East on world crude oil supplies.

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
ANNUAL OUTLOOK FOR OIL AND GAS 1991

Petroleum Supply and Disposition Balance

Supply and Disposition	1988	1990	1995	Reference Case 2000	2005	2010
World Oil Price (1989 $/bbl)	**18.81**	**21.81**	**24.00**	**25.70**	**31.00**	**34.20**
Supply (million b/d)						
Production						
Crude Oil	7.61	7.30	6.79	5.36	4.59	4.42
Natural Gas Plant Liquids	1.55	1.55	1.55	1.67	1.68	1.62
Other Domestic	0.06	0.07	0.19	0.27	0.35	0.48
Processing Gain	0.66	0.67	0.64	0.66	0.64	0.63
Total Production	**9.88**	**9.59**	**9.16**	**7.95**	**7.26**	**7.15**
Imports (including SPR)						
Crude Oil	5.84	5.88	6.35	8.62	9.25	9.29
Refined Products	2.22	2.08	2.51	2.67	3.68	4.56
Total Imports	8.06	7.95	8.86	11.29	12.93	13.85
Exports	0.86	0.86	0.76	0.78	0.82	0.87
Net Imports (including SPR)	7.20	7.09	8.10	10.51	12.11	12.98
Primary Stock Changes						
Net Withdrawals	0.12	−0.08	−0.02	−0.03	−0.02	−0.01
SPR Fill Rate Additions(-)	−0.06	−0.03	−0.05	−0.05	0.00	0.00
Total Supply	**17.33**	**16.92**	**17.34**	**18.53**	**19.49**	**20.27**
Products Supplied (million b/d)						
Motor Gasoline	7.33	7.21	7.22	7.50	7.83	8.08
Jet Fuel	1.49	1.49	1.61	1.82	2.01	2.22
Distillate Fuel	3.14	3.02	3.25	3.49	3.70	3.87
Residual Fuel	1.41	1.23	1.29	1.53	1.53	1.47
Other Petroleum Products	3.96	3.97	3.97	4.20	4.41	4.62
Total Products Supplied	**17.33**	**16.92**	**17.34**	**18.53**	**19.49**	**20.27**
Product Consumption						
Residential and Commercial	1.41	1.33	1.25	1.11	0.99	0.89
Industrial	4.32	4.25	4.46	4.85	5.19	5.51
Transportation	10.86	10.79	10.98	11.67	12.44	13.13
Electric Utilities	0.74	0.55	0.65	0.90	0.86	0.74
Total Product Consumption	**17.33**	**16.92**	**17.34**	**18.53**	**19.49**	**20.27**
End-Use Prices						
(1990 dollars per gallon)						
Motor Gasoline	1.07	1.16	1.22	1.28	1.44	1.53
Jet Fuel	0.61	0.77	0.74	0.78	0.92	1.00
Distillate Fuel	0.92	1.06	1.07	1.12	1.26	1.35
Residual Fuel-Utilities	0.44	0.49	0.65	0.68	0.80	0.88
LPG	0.50	0.74	0.62	0.65	0.75	0.81

Despite the inflated prices in 1990, the projection during the 5-year period 1990 to 1995 is for the crude oil price to move up, increasing 10%. From 1995 to 2000, the price increases only 7.1% to $25.70/bbl. During the 10-year span 1990 to 2000, the price is projected to be up 17.8%. During the next 10 years, 2000 to 2010, the price is projected to increase 33.1% to $34.20/bbl.

In the Low Oil Price Case world crude oil prices fall to $19.00/bbl in 1995, and then move up to $20.10/bbl in 2000, $21.70/bbl in 2005, and $23.40/bbl in 2010. In this case prices fall 12.9% from 1990 to 1995. Then crude oil prices move up 5.8% from 1995 to 2000. During the 10 years, 1990 to 2000, prices fall 7.8%. During the next 10 years, 2000 to 2010, prices move up 16.4% to $23.40/bbl.

Under the High Oil Price Case the rate of increase is much greater. Under this case the world crude oil price jumps to $29/bbl in 1995, $31.10/bbl in 2000, $38.20/bbl in 2005, and

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
ANNUAL OUTLOOK FOR OIL AND GAS 1991

Natural Gas Supply, Consumption, and Prices

Supply, Consumption and Prices	1989	1990	Reference Case 1995	2000	2005	2010
Supply (trillion cubic feet)						
Dry Production	17.25	17.51	18.22	19.62	19.82	19.08
Synthetic Production	0.11	0.11	0.11	0.12	0.19	0.23
Net Pipeline Imports	1.28	1.42	2.00	2.04	2.25	2.32
Net LNG Imports	−0.01	−0.01	0.29	0.52	0.70	0.77
Net Storage Withdrawa s	0.32	−0.52	0.00	0.00	0.00	0.00
Total Supply	**18.95**	**18.50**	**20.62**	**22.30**	**22.96**	**22.40**
Consumption (trillion cubic feet)						
Residential	4.78	4.41	4.71	4.72	4.67	4.55
Commercial	2.72	2.67	2.76	2.84	2.88	2.89
Industrial	6.82	7.18	7.17	7.49	7.06	6.79
Lease & Plant Fuel	1.07	1.22	1.10	1.18	1.19	1.15
Pipeline Fuel	0.63	0.59	0.67	0.73	0.75	0.75
Electric Utilities	2.79	2.78	3.59	4.67	5.69	5.54
Transportation	—	—	—	0.01	0.03	0.06
Total Consumption	**18.80**	**18.83**	**20.01**	**21.64**	**22.27**	**21.73**
Unaccounted for	0.15	−0.33	0.61	0.66	0.69	0.67
Price (1990 dollars per thousand cubic feet)						
Average Wellhead	1.76	1.72	2.12	2.61	4.09	5.04
Average Delivered						
Residential	5.87	5.77	6.25	6.75	8.23	9.17
Commercial	4.93	4.83	5.36	5.86	7.34	8.29
Industrial	3.09	2.92	3.42	3.91	5.40	6.35
Electric Utilities	2.52	2.34	2.81	3.27	4.74	5.65
Transportation	—	—	—	6.79	8.28	9.23
Average to All Sectors	**4.39**	**4.13**	**4.32**	**4.72**	**6.14**	**7.09**

$45.40/bbl in 2010. Prices move up 33% between 1990 and 1995. Prices move up another 7.2% between 1995 and 2000. The 10-year price increase between 1990 and 2000 is projected at 42.6%. The prices continue to move up increasing another 46% from 2000 to 2010.

According to the EIA report *Annual Outlook for Oil and Gas 1991*, the economic growth rate in the Reference Case is set at 2.1%/year. That same economic growth rate is also assumed for the Low Oil Price and High Oil Price Cases. Under the High Economic Growth Case the economic growth rate is assumed to be 2.8%/year. During the past 10 years the growth in gross national product (GNP) averaged 2.7% per year.

In the annual energy outlook, the EIA projects a continuing improvement in energy efficiency during the forecast period for all cases. The trend in the ratio of energy use to economic output has been declining since 1970. U.S. energy consumption is expected to increase at about half the rate of economic growth during the forecast period. Energy efficiency improvements and shifts in economic activity from energy intensive sectors to less energy intensive sectors will slow energy consumption.

These assumptions are part of the basis for the EIA outlook for U.S. oil and natural gas from now to the year 2010. Following is a brief summary of the EIA projections for oil and natural gas consumption and production during the forecast period.

Under the EIA Reference Case, the consumption of petroleum products is expected to continue to be strong. According to the

report, "Declines in the residential sector and commercial sector will be offset by increases in other sectors due to a general growth in the population and the economy. Even though motor gasoline consumption is not expected to grow as rapidly as other transportation fuels, increases in jet and diesel fuel result in an annual growth rate of 1% in the transportation sector in the years following 1990."

In all cases petroleum product prices are forecast to increase. In the Reference Case and the High Oil Price Case, petroleum product prices are expected to increase more slowly than the world oil price. In the Low Oil Price Case and High Economic Growth Cases petroleum product prices increase because of higher costs of transportation and distribution. In the latter cases product prices move up faster than world crude oil prices.

Under the Reference Case price scenario the EIA projects U.S. total demand (total products supplied) for petroleum products to move up to 17.34 million bbl/d in 1995. Demand will then move up to 18.53 million bbl/d in 2000, 19.49 million bbl/d in 2005, and 20.27 million bbl/d in 2010. This is an increase of only 2.5% from 1990 to 1995 and 6.9% from 1995 to 2000. During the 10-year span 1990 through 2000, the rate of growth is projected at 9.5%. During the next 10 years, 2000 to 2010, total demand is projected to move up another 9.4%.

The transportation sector is expected to remain the leading user of petroleum products through 2010, accounting for about two-thirds of petroleum consumption in all cases. In the Reference Case, the share of motor gasoline consumption in the transportation sector is expected to decline from 62% in 1989 to about 55.5% in 2010, mainly due to growth in the demand for other transport petroleum products such as jet and diesel fuel.

The price of transportation fuels is expected to be higher because of changes in product specifications, process and distribution system modifications, and tax increases which will occur during the forecast period. Specific cost increases for motor gasoline derive from summertime volatility limits, reformulated gasoline beginning in 1995, the 1990 federal gasoline tax, and the phased-in California motor gasoline tax increase. Specific diesel fuel cost increases derive from desulfurization in 1993, the 1990 federal diesel fuel tax, and the phased-in California diesel fuel tax increase. Additional costs for upgrading of underground storage tanks affect both motor gasoline and diesel fuel prices.

It is pointed out in the report that, "The composition of gasoline and on-highway diesel fuels will change during the next 20 years as a result of the new Clean Air Act amendments. Starting in November 1992 gasoline sold in about 40 U.S. localities that have been unable to meet federal standards in regard to carbon monoxide in the atmosphere will have to contain a minimum of 2.7% oxygen (by weight) for at least four winter months. Beginning in 1995, all gasoline sold in the nine areas that are farthest from satisfying the standards for ground-level ozone (one of the causes of smog) must be reformulated."

The report further points out that, "All these new regulations will change the basic composition of the leading petroleum products and reduce the possibilities of making them interchangeable across seasons, locations, and uses. This affects refiners, shippers, storers, importers, and marketers; and the changes are expected to increase supply costs in addition to the cost of production. Some of the new Clean Air Act amendments also increase the demand by electric utilities and other power generators for residual fuel oil that is low in sulfur."

Demand for motor gasoline is expected to move up only 4% during the 1990 to 2000 period. During the next 10-year span, 2000 to 2010, demand is expected to move up

7.7%. The increase will be 12.1% during the entire forecast period 1990 to 2010. Motor gasoline demand will move up only slightly from 7.21 million bbl/d in 1990 to 7.22 million bbl/d in 1995. Demand will increase to 7.5 million bbl/d in 2000, 7.83 million bbl/d in 2005, and 8.08 million bbl/d in 2010.

Commenting on motor gasoline demand the EIA report states, "Motor gasoline is likely to remain the predominant highway fuel. Depending on the level of economic activity, highway travel by autos and light trucks is forecast to increase at an annual average rate of between 1.5% and 2.1% per year. The total of vehicle miles traveled by 2010 would be between one-fifth and one-third higher than it has been in the recent past. Personal travel is not expected to reach a saturation point during the next two decades."

Distillate demand is forecast to increase faster than demand for motor gasoline. "Overall diesel fuel consumption is expected to experience a slightly higher rate of growth than motor gasoline due to a continuing trend to use diesel powered vehicles for short-haul activities. For example diesel fuel consumption grows at a rate of 1.7% per year between 1989 and 2010 in the Reference Case."

Total distillate demand is projected to move up from 3.02 million bbl/d in 1990 to 3.25 million bbl/d in 1995 and 3.49 million bbl/d in 2000. Demand will move up to 3.87 million bbl/d by 2010 under the Reference Case. Demand will move up 28.1% during the 20-year span 1990–2000.

Demand for jet fuel is projected to move up 22.1% from 1.49 million bbl/d in 1990 to 1.82 million bbl/d in 2000. Demand will move up another 22% to 2.22 million bbl/d by 2010. During the 20-year span 1990–2000 jet fuel demand is forecast to move up 49%.

According to the EIA outlook, "Jet fuel is the fastest growing petroleum product in all the cases examined. This is predicted on a surge in both freight and passenger miles traveled." Jet fuel consumption is expected to increase 1.9% per year between 1990 and 2010 in the Reference Case to 2.2 million bbl/d: this represents 16.8% of the energy consumed for transportation. Driven by the strong demand for fuel, prices are expected to have the highest rate of growth in the transportation sector. In the Reference Case, the 2010 jet fuel prices are expected to be $1.00/gal, compared to $.61 /gal in 1988 and $.77/gal in 1990.

Demand for residual fuel oil is projected to increase 24.4% by the year 2000, moving up from 1.23 million bbl/d in 1990 to 1.53 million bbl/d in 2000. Between 2000 and 2010 demand is expected to fall 3.9% to 1.47 million bbl/d at the end of the forecast period, 2010. During the 20-year span, demand will be up 19.5%. In the industrial sector the increased consumption of low sulfur residual fuel in preference to high sulfur residual fuel, caused by requirements in the Clean Air Act amendments, is expected to drive up the average price of residual duel, especially in the Low Oil Price and High Economic Growth Cases. Residual fuel prices are the only petroleum product prices that are expected to increase faster than the world oil prices. Overall the price of residual fuel in the industrial sector is expected to remain competitive with natural gas prices in the Reference Case. The 2010 average residual fuel price in the industrial sector is expected to be $33.86/bbl compared with $16.35/bbl in 1989.

Residual fuel consumption for railroads and vessel bunkering is also expected to increase 0.8% per year between 1989 and 2010 in the Reference Case.

In the electric utility sector residual fuel consumption rises during the 1990s but tapers off by 2010. The price of residual fuel increases in the Reference Case to $37.14/bbl

HIGHLIGHTS
INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA
LONG-RUN FORECAST OF U.S. OIL AND GAS TRENDS

U.S. Energy Consumption by Source
(Quadrillion BTU)

	1991	1995	2000	1991-95 % change	1995-2000 % change
Petroleum	33.36	35.38	37.24	6.1	5.2
Natural Gas	19.37	20.60	22.10	6.4	7.3
Coal	18.97	20.17	21.58	6.3	7.0
Hydro & Geoth.	3.68	3.76	3.89	2.1	3.5
Nuclear	5.88	6.40	6.52	9.0	1.8
Total	**81.25**	**86.32**	**91.32**	**6.2**	**5.8**

Source: IPAA Supply and Demand Committee

in 2010 from $18.57/bbl in 1989. The shift to low sulfur residual fuel is expected to drive up the price.

On the supply side, the EIA report projects declining domestic crude oil production throughout the forecast period. U.S. crude oil production is projected to fall from 7.3 million bbl/d in 1990 to 6.79 million bbl/d in 1995. Production will continue to slide to 5.36 million bbl/d in 2000 and down to 4.42 million bbl/d in 2010. Production will be down 39.5% during the 20 years 1990 to 2000.

One of the major reasons for the steep drop in production is that Alaskan production is also forecast to fall steadily during the forecast period. Alaskan production is projected to drop from 1.77 million bbl/d in 1990 to 1.32 million bbl/d in 1995 and 900,000 bbl/d in 2000. Alaskan output will dip to 780,000 bbl/d by 2010. Lower-48 production is also forecast to continue to fall, dropping from 5.53 million bbl/d in 1990 down to 3.64 million bbl/d in 2010.

Commenting on domestic crude oil production, the EIA report states, "The projected decline in total crude oil production is exacerbated by a decline in Alaskan production that is largely caused by the projected production decline in the Prudhoe Bay Field.

There is no production from the Arctic National Wildlife Refuge (ANWR) included in the current forecasts because exploration and development in that area is not allowed at present.

Future offshore production in the lower-48 will depend significantly on the impact of environmental restrictions regarding leasing in offshore regions.

Over the forecast period a considerable amount of oil is expected to come from enhanced oil recovery (EOR)."

With increasing demand and declining domestic production, imports of crude oil and petroleum products are projected to increase throughout the forecast period. In the Reference Case total imports are projected to move up from 7.95 million bbl/d in 1990 to 8.86 million bbl/d in 1995 and 11.29 million bbl/d in 2000. Imports will continue to move up, reaching 13.85 million bbl/d in 2010.

Crude oil imports are projected to move up from 5.88 million bbl/d in 1990 to 8.62 million bbl/d in 2000 and 9.29 million bbl/d in 2010. Product imports will more than double during the forecast period. They will increase from 2.08 million bbl/d in 1990 to 2.67 million bbl/d in 2000 and 4.56 million bbl/d in 2010.

Net imports (total imports minus exports) are forecast to increase 83.1% to 12.98 million bbl/d in 2010. Net imports as a percentage of domestic demand is projected to move up from 41.9% in 1990 to 56.7% in 2000 and 64% in 2010.

HIGHLIGHTS
INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA
LONG-RUN FORECAST OF U.S. OIL AND GAS TRENDS

U.S. Petroleum Supply & Demand Forecast

(Thousand b/d)	1991	1995	2000	1991-95 % change	1995-2000 % change
Demand					
Domestic Demand	16,819	17,850	18,599	6.1	4.2
Exports	867	820	820	– 5.4	—
Total Demand	**17,686**	**18,670**	**19,419**	**5.6**	**4.0**
SUPPLY					
Production					
Crude Oil	7,262	6,401	5,703	– 11.9	– 10.9
NGL	1,560	1,568	1,556	0.5	– 0.8
Total Production	**8,822**	**7,969**	**7,258**	**–9.7**	**–8.9**
Imports					
Crude Oil	6,010	7,179	8,043	19.5	12.0
Products	1,932	2,554	3,115	32.2	22.0
Total Imports	**7,942**	**9,734**	**11,158**	**22.6**	**14.6**
Other Supply	922	1,035	1,093	12.3	5.6
Total Supply	**17,686**	**18,738**	**19,510**	**5.9**	**4.1**

Source: IPAA Supply and Demand Committee

A major reason for the sharp increase in petroleum product imports is refining capacity in the United States. "Because of environmental requirements that add to refining costs and make it difficult to get permits for expansion, overall domestic distillation capacity is assumed to reach only 15.9 million bbl/d during the forecast period. Refiners are expected to continue to invest primarily in downstream additions to process progressively heavier crude oil input and to produce product to satisfy tighter environmental specifications."

This EIA report also projects the future for the U.S. natural gas industry during the forecast period 1990–2010. Commenting on the natural gas market the report states, "Projections of the future course of the domestic natural gas market depend in part on the continued success of changes in the federal regulation of the natural gas industry that are attempting to produce a more market-oriented system."

In addition the report states, "The development of the new rate structure will have lasting effects on the ability of the natural gas industry to expand its markets. Competition with other fuels with respect to both price and environmental effects also will have an impact on the future demand for natural gas.

The active spot market which developed in the 1980s has been an important part of the movement toward a more competitive natural gas market.

In the future the natural gas market is expected to expand or contract more rapidly in response to market fluctuations. Increased competitive pressures will allow the industry to satisfy varying demand levels with market based competitive prices."

With regard to natural gas prices over the forecast period, the EIA states, "The costs of producing and transporting gas over the long-term are expected to remain low enough that in most cases end-use customers will have little incentive to switch to residual or distillate fuel oil, in spite of the increasing share of gas produced from more expensive sources."

The average wellhead price for natural

gas in 1990 dollars is projected to move up from $1.72/mcf in 1990 to $2.61/mcf in 2000 and $5.04/mcf in 2010. The increase during the 20-year period will be 193%, compared to 56.8% for crude oil.

Consumption of natural gas is expected to show substantial increases during the forecast period. Consumption of natural gas by electric utilities and industry leads growth, but several factors move to limit consumption in the early part of the next decade.

Demand for natural gas is expected to increase steadily through 2005. Consumption will move up from 18.83 tcf in 1990 to 20.01 tcf in 1995, 21.64 tcf in 2000, and to 22.27 tcf in 2005. In that year consumption will be up 18.3% from 1990. Demand is projected to then slip to 21.73 tcf in 2010, down 2.4%.

The major increase will be in natural gas consumption in the electric utility sector. Electric utility consumption is projected to increase through 2005, moving up from 2.78 tcf in 1990 to 5.69 tcf in 2005. After 2005 electric utility demand will fall, dropping 2.6% to 5.54 tcf in 2010.

With regard to electric utility demand, the EIA report states, "Over the next decade electric utilities are expected to meet additional peaking and intermediate load requirements with the use of small gas-fired combined cycle and combustion turbine plants. This drives the significant increase projected in electric utility use of natural gas into the post 2000 period. After the turn of the century utilities are expected to move toward coal-based generation to meet additional baseload capacity requirements. Thus the outlook for continued growth of natural gas in this sector is limited throughout the remainder of the forecast period."

Industrial sector demand for natural gas is projected to move up from 7.18 tcf in 1990 to 7.49 tcf in 2000. Demand will then fall, reaching 6.79 tcf in 2010. "Natural gas consumption begins to decline slowly at the turn of the century as the mix of industries composing the industrial sector continues to shift away from those industries that use natural gas intensively."

Residential consumption of natural gas is projected to move up from 4.41 tcf in 1990 to 4.72 tcf in 2000. Consumption is then expected to slide to 4.55 tcf in 2010. Consumption in the commercial sector is forecast to move up from 2.67 tcf in 1990 to 2.84 tcf in 2000 and 2.89 tcf in 2010. Commenting on the demand in these sectors the report states, "Although increases in the use of natural gas appliances (particularly in space heating and water heating applications) are expected, efficiency improvements are expected to offset the impact of greater numbers of appliances in service."

U.S. domestic production of dry gas is projected to move up through 2005. Output will increase from 17.51 tcf in 1990 to 19.82 tcf in 2005, an increase of 13.2%. From 2005 through 2010 production is forecast to slip 3.7% to 19.08 tcf. According to the EIA report, "Production from unconventional sources and Alaska are projected to increase significantly by 2010, and to offset production declines of offshore and associated dissolved natural gas. After reaching a peak of 20.1 tcf in 2002, domestic production is projected to decline to 19.1 tcf by 2010, corresponding to a decline in industrial consumption and offset by increased use of natural gas imports and synthetic natural gas."

Total imports of natural gas, both pipeline and LNG, will increase steadily through the forecast period. Total imports will move up from 1.51 tcf in 1990 to 3.16 tcf in 2010. Imports from Canada are projected to move up from 1.47 tcf in 1990 to 2.03 tcf in 1995 and remain at that level through 2005. Imports from Canada will then slip to 1.85 tcf by 2010. Imports from Mexico are projected to

start in 2000 and reach 500 bcf by 2010. LNG imports are projected to move up steadily and reach 820 bcf by 2010.

WORLDWIDE OUTLOOK. To look at the worldwide energy and oil markets, the EIA developed and published a separate report *International Energy Outlook 1991: A Post-War Review of Energy Markets*. The report was published at the end of June 1991.

The EIA report concludes that future worldwide crude oil prices will be dependent upon the production decisions made by OPEC. The ability of OPEC to manage production to coincide with demand will determine the crude price level.

With regard to crude oil prices the EIA report states, "The long-term impact of the war on world oil markets is expected to be limited, because other countries such as Saudi Arabia can easily expand production capacity to make up any shortfalls from Iraq and Kuwait. Except for the near-term restoration of capacity in Iraq and Kuwait most of the trends that existed prior to the August 2, 1990 invasion of Kuwait are expected to continue for the foreseeable future. Beyond the mid-1990s the prices are expected to rise. Non-OPEC production is expected to peak and level off by the end of the decade, while production in the United States continues to decline." The report goes on to say, "At the same time world oil demand is expected to keep growing in response to the relatively low world oil prices of the last few years. Even with a firming of world oil prices over the next few years, prices would still be low compared with historical levels since the early 1970s. These demand increases are expected to outweigh increases in production from non-OPEC sources, resulting in increased reliance on OPEC oil in the future."

The EIA report comments on the impact of these trends on oil prices stating, "The degree to which oil prices will rise depends largely on OPEC's behavior. Market share and revenue goals, as well as political and security considerations, will influence OPEC's production and capacity decisions. The most likely course is that the pressure to earn more revenue, along with the desire to gain leverage in OPEC's production decision making process, will encourage OPEC member nations to expand their production capacities in the future. Continued capacity expansion should moderate increases in oil prices in the future."

The EIA report projects that world oil prices, in 1990 dollars, will slip to $17.60/bbl in 1991, from $21.78/bbl in 1990. The price is projected to move up to $20.80/bbl in 1995 and $26.40/bbl in 2000. The EIA projects real crude oil prices will rise another 26.5% to $33.40/bbl in 2010.

According to the EIA, "World consumption of total primary energy is projected to grow steadily between now and 2010, spurred primarily by continued economic growth. Oil will continue to be the most important single source of energy, but its share of total energy consumed is expected to decline. All other fossil fuels are expected to maintain or increase their relative importance moderately. As with economic growth, energy consumption will grow much more rapidly in the developing countries than in the OECD countries or in the CPEs."

With regard to world energy consumption by region the EIA report stated, "In terms of total energy consumption, the United States, the Soviet Union, and OECD Europe were the largest consumers of energy in 1989 and will remain the largest consumers through 2010.

Japan is expected to expand both nuclear production and natural gas imports substantially over the projection period. These

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
INTERNATIONAL ENERGY OUTLOOK 1991

World Oil Consumption and Production Base Case

	1988	1989	1990	1995	2000	2010
Market Economies						
Production: (million b/d)						
United States	10.47	9.88	9.60	8.6	7.9	7.2
Canada	2.04	2.03	1.98	2.1	2.2	2.2
OECD Europe	4.48	4.41	4.50	5.4	5.1	3.9
OPEC	21.85	23.83	24.92	28.7	32.3	39.8
Other countries	10.06	10.33	10.76	11.6	11.6	10.4
Net CPE Exports	2.17	1.83	1.87	0.8	0.2	- 0.6
Total	**51.08**	**52.31**	**53.62**	**57.2**	**59.4**	**62.9**
Consumption: (million b/d)						
U.S. (50 states)	17.28	17.33	16.92	17.9	18.6	20.5
U.S. Territories	0.19	0.19	0.20	0.2	0.2	0.2
Canada	1.69	1.76	1.73	1.9	2.0	2.1
Japan	4.75	4.98	5.23	6.0	6.4	6.3
Australia & New Zealand	0.75	0.78	0.81	0.9	0.9	1.0
OECD Europe	12.43	12.56	12.67	13.6	13.8	13.7
Other market economies	13.90	14.70	15.40	16.9	17.8	19.4
Total	**50.99**	**52.31**	**53.00**	**57.5**	**59.7**	**63.2**
Discrepancy	- 0.08	- 0.01	- 0.67	0.3	0.3	0.3
Centrally Planned Economies (CPE)						
Production: (million b/d)						
China	2.73	2.76	2.77	2.9	3.1	3.7
Soviet Union	12.50	12.14	11.43	9.6	9.9	10.2
Other	0.44	0.43	0.43	0.5	0.6	0.9
Total	**15.67**	**15.33**	**14.63**	**12.9**	**13.6**	**14.8**
Consumption: (million b/d)						
China	2.15	2.28	2.31	2.7	3.3	4.1
Soviet Union	8.89	8.80	8.23	7.2	7.6	8.9
Other	2.47	2.42	2.23	2.3	2.6	2.5
Total	**13.51**	**13.49**	**12.77**	**12.1**	**13.4**	**15.4**
World Oil Consumption	**64.50**	**65.80**	**65.77**	**69.7**	**73.2**	**78.7**
World Oil Price (1990 dollars/bbl)	**15.77**	**18.81**	**21.78**	**20.8**	**26.4**	**33.4**

actions will diversify Japan's sources of energy and consequently reduce its energy vulnerability.

Rapid growth in total energy demand in the developing countries will result from higher population growth and increasing urbanization and industrialization. Economic growth will be particularly strong among the newly industrialized countries, particularly along the Pacific Rim, where manufacturing activities have flourished. Urbanization increases energy demand as the economy shifts from agriculture to industry and services, and from smaller to larger manufacturing operations. These shifts, in turn, require increased transportation, electrification, and mechanization, all energy intensive activities."

Although there is a move toward market economies, the EIA report still referred to the group of Centrally Planned Economies (CPE). For these countries as a group the EIA report stated, "The economic outlook for the CPEs varies considerably by country. As a group the CPEs represented about 16% of total world gross domestic production (GDP) in 1990. This total is expected to drop markedly to between 14 and 15% by 1995, and to remain at those levels through the next decade.

The primary reason for this drop is the negative growth rate expected for the Soviet Union for the next few years as a result of its economic crisis." They assume the USSR econ-

HIGHLIGHTS
INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA
LONG-RUN FORECAST OF U.S. AND GAS TRENDS

U.S. Natural Gas Supply & Demand Forecast

(Billion cubic feet)	1991	1995	2000	1991-95 % change	1995-2000 % change
Disposition					
Consumption					
Residential	4,500	4,759	4,805	5.8	1.0
Commercial	2,687	2,836	2,950	5.5	4.0
Industrial	6,990	7,496	7,807	7.2	4.1
Electric Utilities	2,808	3,335	4,562	18.8	36.8
Total To Consumers	**16,985**	**18,426**	**20,124**	**8.5**	**9.2**
Lease/Plant Fuel	1,171	1,211	1,235	3.4	2.0
Pipeline Fuel	588	648	690	10.2	6.5
Total Consumption	**18,744**	**20,284**	**22,049**	**8.2**	**8.7**
Exports	101	104	111	3.0	6.7
Additions to Storage	2,277	2,401	2,376	5.4	- 1.0
Unaccounted for	119	121	210		
Total Disposition	**21,241**	**22,910**	**24,744**	**7.9**	**8.0**
Supply					
Production (Dry)	17,345	18,132	19,119	4.5	5.4
Total Imports	1,563	2,187	2,954	39.9	35.1
Withdrawals from Storage	2,210	2,485	2,511	12.4	1.0
Supplemental Gas Fuels	123	106	161	- 13.8	51.9
Total Supply	**21,241**	**22,910**	**24,744**	**7.9**	**8.0**

Source: IPAA Supply and Demand Committee

omy will stabilize in the mid-1990s and then grow very slowly at between 1% and 2% through 2010.

The economic outlook for the Eastern European counties is for no growth from 1990 through 1995, followed by an annual growth rate of almost 2% after the mid-1990s.

China is expected to continue its current annual growth rate of 7.5% until the end of the decade, and at over 6% during the following 10 years.

The following information is a review of some of the EIA international worldwide projections.

Total world energy consumption is projected to increase 32.2% during the forecast period 1989 through 2010, moving up to 455 quadrillion BTU from 344.1 quads in 1989. Energy consumption by the market economies is projected to increase 33.9% during the period, moving up to 313 quads in 2010 from 233.8 quads in 1989. Energy consumption by the CPEs is projected to increase 27.8% to 141 quads in 2010. CPE energy consumption is projected to increase only 3.4% from 1989 to 1995.

Total consumption of petroleum products by the Market Economies is projected to increase throughout the forecast period 1989–2010. Demand is projected to move up 14.1% by 2000, to 59.7 million bbl/d. Demand will be up 20.8% from 1989 at 63.2 million bbl/d in 2010. U.S. demand is expected to rise throughout the period, increasing 18.4% to 20.5 million bbl/d in 2010. Japanese demand will peak in 2000 at 6.4 million bbl/d and then fall to 6.3 million bbl/d in 2010. Demand in 2010 will be 26% above 1989. Petroleum product demand in the European OECD countries will follow a similar pattern, rising to 13.8 million bbl/d in 2000 and then declining to 13.7 million bbl/d in 2010. Demand in 2010 will be

up 8.7% from the 12.6 million bbl/d in 1989.

Demand in the OPEC countries is projected to move up 39% to 5.7 million bbl/d in 2010. Demand in the other developing countries will move up throughout the forecast period increasing 29.2% to 13.7 million bbl/d in 2010.

On the supply side of the equation crude oil production in the Market Economies is also projected to increase throughout the forecast period to keep pace with demand. Imports from the CPEs will decline throughout the forecast period, so production will have to move up slightly faster than demand.

Crude oil production will move up 25.8% to 63.5 million bbl/d in 2010. This will be an increase of 13.02 million bbl/d. U.S. production will decline throughout this period, falling 2.69 million bbl/d to 7.2 million bbl/d in 2010. Canadian production will be up 8.4% in 2010. European production will peak in 1995 at 5.4 million bbl/d. Production will then fall back to 5.1 million bbl/d in 2000 and 3.9 million bbl/d in 2010. Other non-OPEC production will peak in 1995 at 10.6 million bbl/d, and stay at this level through 2000 before falling to 10.4 million bbl/d in 2010.

Increased OPEC production will make up for most of the increase in worldwide demand for oil. OPEC production will increase 74.3% to 39.8 million bbl/d in 2010, an increase of 15.97 million bbl/d.

Imports from the CPEs are expected to fall from 1.83 million bbl/d in 1989 to 800,000 bbl/d in 1995 and 200,000 bbl/d in 2000. After 2000, the imports from the CPEs will decline rapidly and by 2010 EIA expects these counties to be net importers of about 600,000 bbl/d.

Looking at the worldwide energy mix over the forecast period, the EIA concluded that, "Oil will continue to be the most important single source of energy, but its relative importance—share of total energy consumed—is expected to decline. All other fossil fuels are expected to maintain or increase their relative importance moderately."

Natural gas is expected to be the fastest growing fossil fuel through the year 2010. Natural gas supplies are abundant relative to oil supplies and relative to its lower absolute level of consumption. Natural gas consumption is projected to move up 41.1% to 101 quads in 2010. The natural gas share of total world energy is projected to increase to 22.2% from 20.8% in 1989. In the market economies the natural gas share will move up to 21.7% from 18.7% in 1989.

In the CPEs, the EIA expects oil consumption to fall sharply through 1995, falling 10.3% to 12.1 million bbl/d in 1995. Consumption will then move up to 13.4 million bbl/d in 2000. However this will be only back to the 1989 level of 13.49 million bbl/d. Demand will move up more rapidly as economic growth improves, reaching 15.4 million bbl/d in 2010. During the period 1989–2010, demand will be up 1.91 million bbl/d.

Consumption in these countries will decline in the early years of the forecast period due to the economic turmoil resulting from the political upheaval. In addition, these countries will be changing there economies and adopting new technologies that conserve energy.

Consumption in the USSR is projected to fall from 8.8 million bbl/d in 1989 to 7.2 million bbl/d in 1995. Demand is then expected to move up, reaching 7.6 million bbl/d in 2000 and 8.9 million bbl/d in 2010.

In the other Eastern European countries, consumption will also fall between 1989 and 1995, dipping 5% to 2.3 million bbl/d. Demand will then move up to 2.6 million bbl/d in 2000 and fall slightly to 2.5 million bbl/d in 2010. Consumption in China is expected to move up during the forecast period increasing 79.8% to 4.1 million bbl/d.

Demand is expected to fall until 1995 and then increase. And oil production by this

group of countries is projected to follow a similar pattern throughout the forecast period. In 1989 total production for the CPEs was 15.33 million bbl/d. This is projected to fall sharply to 12.9 million bbl/d in 1995. Production will then move up to 13.6 million bbl/d in 2000 and 15.4 million bbl/d in 2010. Production in the USSR is projected to fall from 12.14 million bbl/d in 1989 to 9.6 million bbl/d in 1995. Output is then expected to move up to 10.2 million bbl/d in 2010. Chinese production is projected to rise throughout the forecast period. China's production averaged 2.76 million bbl/d in 1989 and is expected to move up to 2.9 million bbl/d in 1995. It will then increase to 3.1 million bbl/d in 2000 and 3.7 million bbl/d in 2010.

By the year 2010 the CPEs will no longer be self sufficient in petroleum. In that year consumption will exceed production by 600,000 bbl/d. The USSR will be producing enough oil to meet their consumption needs, but not enough to cover the needs of the other CPEs. According to these projections, China will become a net importer by 2000 when consumption will exceed production by 200,000 bbl/d. In 2010 the gap between production and consumption in China will move up to 400,000 bbl/d.

INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA IPAA SUPPLY AND DEMAND COMMITTEE

U.S. OUTLOOK. The Supply and Demand Committee of the Independent Petroleum Association of America (IPAA) has been constructing a one-year forecast for the U.S. energy and oil and gas industries for many years. In May 1991, for the first time, the Supply and Demand Committee developed a longer term forecast, *Long-Run Forecast of U.S. Oil and Gas Trends*.

This forecast includes the committee's expectations for U.S. economic growth, U.S. energy consumption, U.S. supply and demand for petroleum, and U.S. supply and demand for natural gas, through the year 2000.

Following are the forecast highlights as presented by the committee.

With regard to the projection of economic activity and inflation the report stated the following:

- The committee forecasts that U.S. real economic activity, as measured by inflation-adjusted Gross National Product (GNP), will increase by an average annual rate of 2.4% (± 0.25%) to the year 2000.
- The growth rate in real economic activity is expected to show a slight acceleration during the course of the 1990s.
- The long-term potential of the U.S. economy has been estimated by some experts to be 2.4% annually. During the 1973–1981 business cycle, the economy grew at an average annual

rate of 2.1%, which is below the long-term trend. The 1981–1990 business cycle saw an average increase in real GNP of 2.8% annually, which is higher than the long-term trend. The committee expects real GNP to return to the long-term potential trend in the coming decade. The reasons include slower growth in productivity and labor force participation, higher expected inflation, and no reduction in marginal tax rates.

- Inflation, as measured by the GNP Implicit Price Deflator, is forecast to average 3.9% annually during the 1990s, ± 0.5%.
- The pace of inflation in the United States is expected to accelerate during the 1990s.
- During the 1980s business cycle, inflation averaged 3.8% annually. This is less than the average rate of 8.3% per year during the 1970s cycle.

The report concluded that the rate of growth in U.S. energy demand will slow in the 1990s. The report highlights concerning U.S. energy consumption during the forecast period are as follows:

- The trend in the Energy/GNP ratio will continue to show gains in efficiency and reduced energy intensity. Energy demand will grow at one-half the rate of economic growth in the coming decade.
- In recent years, oil and natural gas have lost market share to coal and nuclear power. This trend is expected to reverse itself in the future.
- Utility company construction programs for large nuclear and coal plants are winding down.
- Utilization of existing coal plants and new construction will be affected by the Clean Air Act.
- Hydroelectric potential is limited by available development opportunities.
- Marginal growth in energy demand will be met primarily by oil, natural gas, and coal.

The highlights of the committee's forecast of U.S. petroleum supply and demand are as follows

- U.S. crude oil production peaked in 1985 at 9 million bbl/d, declining to an average 7.3 million bbl/d in 1990. The committee forecasts that crude oil output will continue to fall, reaching 5.7 million bbl/d by the end of the century. This is almost 3.3 million bbl/d lower than 1985.
- Total petroleum imports are forecast to rise to an average 11.3 million bbl/d in 2000, about 3 million bbl/d higher than 1991. Increased refinery runs and the expected decline in crude oil production account for the growth.
- By 2000, total petroleum imports are projected to account for 60% of domestic demand compared to 47% in 1991.
- The utilization rate of U.S. refineries in 2000 is expected to be slightly higher than 1990. Increased expenditures necessitated by environmental regulations will adversely affect returns on new refinery investment.
- During the 1980s, domestic petroleum demand showed little overall growth. The most important factors in this trend were conservation measures as a result of price increases, and Corporate Average Fuel Economy (CAFE) requirements.
- The committee expects oil demand to increase in the 1990s at an annual average rate of less than 1%. Competition among energy fuels and continuing efficiency gains are likely to limit higher growth.

With regard to natural gas, the committee report presented the following highlights:

- Domestic natural gas production is fore-

cast to increase to 19.1 tcf by the year 2000, growing annually by an average rate of up to 1.7%. Sufficient incentives are assumed to exist to permit continuing additions to the domestic production capability. Coal bed methane and other supply sources based on improved technology are expected to contribute an increasing share.

- Natural gas imports will rise to 3 tcf by the end of the century.
- The committee forecasts continued growth in natural gas consumption during the 1990s, reaching 22 tcf by the year 2000.
- Most of this growth should originate in the electric utility and industrial markets. New construction in the utility sector is expected to favor natural gas due to the influence of the Clean Air Act and other legislative initiatives. Natural gas also will be the fuel of choice in projects where short lead times are critical.